Original Article

Effect of Microabrasion on Teeth Color

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ABSTRACT

Objective: The aim of this study is to evaluate the enamel color changes before and after microabrasion technique, which is treatment of white spot lesion by using the CIE L*a*b* system with spectrophotometer.

Materials and Methods: Twenty patients with inactive white spot lesions after fixed orthodontic treatment were selected. Especially, only small size white spot areas on central incisors, excluding middle of teeth were accepted. The contents of the microabrasion mixture was 18% hydrochloric acid and pumice (smaller than 30% of buccal area of tooth). The method was applied 4 times for each tooth. The spectrophotometric data on the labial surfaces of teeth were recorded with Easyshade (Vita, Zahnfabrik, Bad Säckingen, Germany) at the center of incisors before and after microabrasion. *In vivo* spectrophotometric color evaluation was adopted for all patients, and all measurements were performed in the same clinic room under standardized lighting conditions. Color on the surfaces of individual teeth was measured for L*, a*, b*, according to CIE L*a*b* color spaces. The data were analyzed by paired *t* test. Means were calculated at the 0.05 level of significance.

Results: Significant differences were seen among L*, a*, b*, values before and after microabrasion ($p<0.05$). L* values were increased after microabrasion processing; a* and b* values were decreased after microabrasion processing. The mean ΔE value was 2.76. ΔE values showed that the color differences were at the acceptable level ($\Delta E<3.3$).

Conclusion: Microabrasion, which is an effective treatment approach for the cosmetic improvement of long-standing postorthodontic demineralized enamel lesion, constituted clinically acceptable color change on teeth. (*Turkish J Orthod* 2013;26:80–84)

KEY WORDS: CIE L*a*b*, Enamel, Microabrasion

INTRODUCTION

Many orthodontic patients are, regrettably, affected by enamel decalcification. When oral hygiene and preventive advice is poor, it is primarily seen in those whose intratreatment compliance.[1,2] Plaque accumulates primarily around brackets in orthodontic patients. Therefore, enamel decalcification occurs in areas of plaque accumulation, and thus is predominantly associated with orthodontic bands and brackets. Appliance design, cementation failure, salivary flow and composition, enamel susceptibility, and of course dietary practices could be charged with the development of these white spot lesions.[3]

Clinically, an early lesion is seen as an opaque and white area because of loss of minerals below the outermost enamel layer. The white spot area is faintly softer than the surrounding sound enamel area. At this stage, forceful probing can cause cavitation. If the patient does not recover oral hygiene motivation, the lesion progresses, and esthetics can become adversely affected, especially if secondary staining occurs after orthodontic treatment. Providing the treatment of white spot lesion that will improve cosmetics without compromising tooth structure is essential. The microabrasion technique obtains these two criteria. Initially, Croll and Cavanaugh[4] described this technique, which involves repeated applications of a pumice and 18% hydrochloric acid slurry to the demineralized tooth surface. The microabrasion technique can improve esthetic results by removing a thin physical discolored enamel layer. After microabrasion treatment,

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the more smooth and lustrous enamel surface is obtained. This smooth and lustrous surface that shows different optical properties can enhance the esthetic appearance.[5]

The evaluation of color, whether by visual or instrumental means, requires an understanding of the parameters with which color is expressed and measured. The Commission Internationale de l'Eclairage (CIE) L*a*b* color space (CIELab) and color difference formula defines color in terms of 3 coordinate values (L*, a*, b*), which locate the color of an object within a 3-dimensional color space. The L* coordinate represents the brightness of an object represented on the y-axis; the a* value represents the red (positive x axis) or green (negative x axis) chroma; and the b* value represents the yellow (positive z axis) or blue (negative z axis) chroma. The color difference (ΔE) of 2 objects can then be determined by comparing the differences between respective coordinate values for each object.[6–8]

These values are differences in color parameters for the 2 specimens measured for comparison. Numeric description of color permits precise definition of the magnitude of the color difference between objects, for example, the porcelain color of a metal ceramic crown and the shade tab or tooth to which it is to match.

A review of the literature showed that although microabrasion changes the teeth color, it is a recommended technique to improve esthetic appearance for postorthodontic white spot lesions. To date, there are no quantitative *in vivo* studies about color change in microabrasion therapy.

The aim of our *in vivo* study was to evaluate the enamel color changes before and after the microabrasion technique by using the CIE L*a*b* system with spectrophotometer. The null hypothesis was that there were no differences in color of intraoral spectrophotometric measurements before and after microabrasion therapy.

MATERIALS AND METHODS

Study patients were recruited from a postorthodontic demineralized lesion database in the Orthodontic Department of Dentistry, University of Selçuk database in the Selcuk University, Faculty of Dentistry, Department of Orthodontics. Only small-size white spot areas, excluding the middle of the teeth were accepted. Each participant was given information about microabrasion therapy and also invited to an appointment in the orthodontic clinic for treatment of white spot lesion, if requested. However, only 20 of the 50 subjects kept these appointments (Table 1).

Inclusion criteria included:

(1) all patients had completed maxillary and mandibular fixed appliance therapy in the Department and had postorthodontic demineralized noncavitated lesions involving maxillary or mandibular incisors or canine except maxillary central incisors,
(2) nonsmoking habits,
(3) no previous bleaching treatment,
(4) absence of plaque accumulation and gingival inflammation, and
(5) absence of dental caries, prosthetic restorations, intrinsic and extrinsic discolorations and morphologic/anatomic deviations in the measured teeth.

The Ethical Committee of the Faculty of Dentistry, University of Selçuk, assured that the procedures detailed in the present clinical study were conducted in accordance with the guidelines of good clinical practice.

Microabrasion Treatment

The microabrasion treatment is applied in the Department of Orthodontics, Faculty of Dentistry routinely. After the debonding process, patients who have white spot lesions are informed about the white spot lesion and microabrasion technique. The technique is applied approximately 3–5 times at 2-week intervals.

For each patient, affected teeth were determined for the microabrasion technique that was described by Croll and Cavanaugh[4,9] and Welbury and Carter.[10] All patients were treated by the same operator (M.A.). In brief, the affected teeth were cleaned with fine pumice and water by using a rubber cup. A rubber dam (SDI Dental Instruments, Väsby, Sweden) was used to isolate these teeth. Eighteen percent hydrochloric acid was mixed with a fine pumice powder to form a slurry. This was then applied to the teeth with a brush (3M Bendable Brushes, 3M Dental Products, St Paul, MN, USA) and agitated. The slurry was applied into the affected tooth surface for 30 seconds and then washed off with an air-water spray. The cycle of acid pumice application, agitation, and washing was repeated 4 times for each experimental tooth. Sodium bicarbonate and water paste were placed

Table 1. Demographic data of patients undergoing microabrasion treatment

	No.	Mean Age	SD	Min–Max[a]
Female	13	14.6	1.9	12.2–15.8
Male	7	14.5	2.1	12.2–16.7

[a] Min indicates minimum; Max, maximum.

on the rubber dam to protect against inadvertent splashing of the hydrochloric acid. Finally, the tooth was washed for 30 seconds. This process was applied 4 times for each patient at 2-week intervals.

Maxillary central teeth were chosen in our study because there were enough unaffected enamel areas for color measurement.

Spectrophotometric Evaluation

All patients who had white spot lesions were called for assessment 8 weeks later, after the debonding process. A standard protocol of tooth preparation and *in vivo* spectrophotometric color evaluation was adopted for all patients, and all measurements were performed in the same examination room on sunny days at 2:00 P.M. with standardized lighting conditions. The patient chair was 135°, and the patient heads were in the same position every time. After the patient had given informed written consent, all demineralized lesions were recorded. The record contains all tooth photographs and color assessment of two maxillary incisors.

Clinical spectrophotometer VITA Easyshade, which comprises a base unit and a hand piece (VITA Zahnfabrik, Bad Säckingen, Germany), was used to measure color differences in each tooth according to the CIE L*a*b* color system. The spectrophotometer was automatically calibrated before each precision, and the probe was applied with anti-infection cover for each patient according to the manufacturer's instructions. All measurements were performed by keeping the tip of the spectrophotometer perpendicular and flush to the tooth surface and in contact with the tooth surface. Especially the color was evaluated from middle of incisors in single tooth mode.

First, the color of 40 central incisors (20 right, 20 left central incisors, 20 patients) was determined shortly after the debonding process. After that, the microabrasion technique described above was applied according to procedure.

The quantitative ΔE values of nonmicroabraded and microabraded teeth were calculated with the following formula:

$$\Delta E = [(L^*_2 - L^*_1)^2 + (a^*_2 - a^*_1)^2 + (b^*_2 - b^*_1)^2]^{1/2}$$

where 1 and 2 represent before and after microabrasion and $L^*_2 - L^*_1$, $a^*_2 - a^*_1$ and $b^*_2 - b^*_1$ show ΔL*, Δa*, and Δb*.

Statistical Analysis

The hypothesis was tested by using a paired *t* test at the 95% confidence level ($p=0.05$). All statistical analyses were performed using the Statistical Package for Social Sciences, version 13.0 (SPSS, Chicago, IL, USA).

RESULTS

The color measurements showed significant changes during the microabrasion technique. ΔL* values, which indicated a moderate increase in lucency and Δa* and Δb* values, which indicate a shift to greener and bluer shades, respectively decreased. Mean values and standard deviations of L*a*b* are shown in Table 2. There were statistically significant differences between $L^*_1 - L^*_2$ and $b^*_1 - b^*_2$ ($p<0.01$) and also $a^*_1 - a^*_2$ ($p<0.05$).

The quantitative ΔE values of nonmicroabraded and microabraded teeth were calculated. The mean ΔE value was 2.76; ΔE value showed that the color differences were at the acceptable level (ΔE<3.3) (Fig. 1).

Table 2. Mean and standard deviation of L*a*b* values[a]

	T1		T2		
	Mean	SD	Mean	SD	*p* Value (Significance $p<0.005$)
L	80.07	2.29	81.33	2.63	<0.01
a	−0.22	0.54	−0.6	0.69	<0.05
b	18.8	2.38	17.03	2.55	<0.01

[a] T1 indicates before treatment; T2, after treatment.

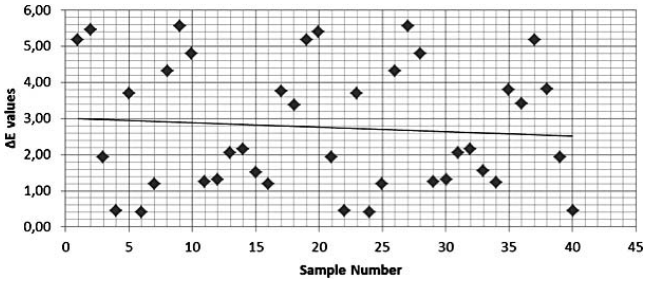

Figure 1. The quantitative ΔE values of samples.

DISCUSSION

The hypothesis was rejected; the results of this study showed that there was an acceptable level of enamel color change during microabrasion therapy.

The primary goal of orthodontic treatment is to give a functional and natural appearance to patients who apply orthodontic clinics, and especially to obtain an esthetically pleasing smile. Since orthodontic treatment continues for a long time and patient motivation to maintain oral hygiene decreases, a demineralized enamel surface occurs, especially around brackets.

At this point, if undesirable white spot lesions are present, microabrasion is a most effective therapy for improving dental esthetic appearance.[5] A highly polished enamel surface is seen as the microabrasion process removes small amounts of surface enamel. The highly polished surface does not have the typical enamel surface appearance because the microabrasion removes interprismatic spaces.[11] The microabrasion process compacts calcium and phosphate into the interprismatic space while abrading enamel surface.[12]

As the microabrasion process abrades surface enamel while compacting calcium and phosphate into the interprismatic spaces, the new polished surface is less susceptible to bacterial colonization and demineralization than natural nonabraded enamel.[13,14] Polished surface reflects light differently than natural enamel because of the compacting of interprismatic spaces.

Dentin plays a major role in tooth color. Light is transmitted in interprismatic spaces and reflects from dentin so that color occurs. After microabrasion therapy, because of the compactness of interprismatic space, light cannot be passed regularly from the dentin surface. Whitened enamel that is apparently compared with the natural tooth enamel can be treated with microabrasion. Microabrasion is just the application of an acidic and abrasive compound to the surface of the enamel.[9,15] Research indicates that 1-minute applications of commercially available microabrasion compounds remove 12 μm on the first application and 26 μm on subsequent applications.[16] As the fluoride-rich enamel that is enamel surface the first application removes less enamel than subsequent applications. Usually, 5 to 10 applications of the microabrasion therapy are enough to be successful in eliminating the undesirable discoloration. A thin layer of surface enamel can be removed by microabrasion therapy; at least a highly polished enamel surface was obtained.[11]

Spectrophotometers are among the most useful and accurate instruments for color measurement in clinical dentistry, and the amount of light energy can be reflected from an object at 1- to 25-nm intervals along the visible spectrum with these instruments.[17–19] A spectrophotometer contains a source of optical radiation, a means of dispersing light, an optical system for measuring, a detector, and a means of converting light obtained to a signal that can be analyzed. The data obtained from spectrophotometers must be converted and translated into a useful format for dental clinicians. It was found that spectrophotometers offered a 33% increase in accuracy and a more objective match in 93.3% of cases in comparison with observations by the human eye, or a conventional technique. Vita Easyshade Compact (Vita Zahnfabrik), which is cordless, small, portable, cost efficient, battery operated, contact-type was chosen in the present study.[6]

The cornerstone for the measurement and evaluation of color differences for dental materials science is the development of the CIELab color system. Over the years, CIELab has been an accepted method for color measurement since each color occupies a unique location in the three-dimensional CIELab color space.[6–8]

In the present study, the aim was to investigate the effect of microabrasion on color changing on enamel surfaces *in vivo*. Less affected central incisors were chosen in the study because of large smooth surfaces and esthetic importance. The white spot lesion areas were so small in central teeth, they did not prevent color measurement.

Color difference (ΔE*) was calculated from the formula previously mentioned. Many authors used ΔE* values to evaluate the “perceptibility” of color differences.[18–20] However, it is noteworthy that the criteria of perceptibility adopted by each author were different. When the color changes ΔE* units less

than 1.0 were not seen by visual, between 1.0 and 3.3 were deemed to be acceptable by clinic.[21,22] The mean of ΔE* values in our study was acceptable (2.76). In addition, in our study the microabrasion therapy made teeth more lucent, greener, and bluer. This observation is supported by Paic *et al*.[23] who had quantitatively evaluated color changes after microabrasion under standardized conditions *in vitro*.

Within the limitations of the present clinical investigation, only central incisors were evaluated because of the deficient unaffected areas of other anterior teeth.

CONCLUSION

Microabrasion therapy is effective in improving the cosmetic appearance of postorthodontic demineralized enamel lesion and at the same time has considerable abrasive potential, causing micromorphologic surface changes. Therefore, it is thought that the color change is a disadvantage of this treatment. The results of this *in vivo* study disclosed that microabrasion therapy makes color changes clinically perceptible.

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REFERENCES

1. Gorelick L, Geiger AM, Gwinnett AJ. Incidence of white spot formation after bonding and banding. *Am J Orthod*. 1982;81:93–98.
2. Ogaard B. Prevalence of white spot lesions in 19-year-olds: a study on untreated and orthodontically treated persons 5 years after treatment. *Am J Orthod Dentofacial Orthop*. 1989;96:423–427.
3. Murray J, Nunn J, Steele J. *The Prevention of Oral Disease*. Oxford, UK: Oxford University Press; 2003:82–83.
4. Croll TP, Cavanaugh RR. Enamel color modification by controlled hydrochloric acid-pumice abrasion. I. Technique and examples. *Quintessence Int*. 1986a;17:81–87.
5. Murphy TC, Willmot DR, Rodd HD. Management of postorthodontic demineralized white lesions with microabrasion: a quantitative assessment. *Am J Orthod Dentofacial Orthop*. 2007;131:27–33.
6. Paul S, Peter A, Pietrobon N, Hammerle CH. Visual and spectrophotometric shade analysis of human teeth. *J Dent Res*. 2002;81:578–582.
7. Seghi RR, Hewlett ER, Kim J. Visual and instrumental colorimetric assessments of small color differences on translucent dental porcelain. *J Dent Res*. 1989;68:1760–1764.
8. Stober T, Gilde H, Lenz P. Color stability of highly filled composite resin materials for facings. *Dent Mater*. 2001;17:87–94.
9. Croll TP, Cavanaugh RR. Hydrochloric acid-pumice enamel surface abrasion for color modification: results after six months. *Quintessence Int*. 1986b;17:335–341.
10. Welbury RR, Carter NE. The hydrochloric acid-pumice microabrasion technique in the treatment of post-orthodontic decalcification. *Br J Orthod*. 1993;20:181–185.
11. Donly KJ, O'Neill M, Croll TP. Enamel microabrasion: a microscopic evaluation of the "abrosion effect." *Quintessence Int*. 1992;23:175–179.
12. Donly KJ, Sasa I. Potential remineralization of postorthodontic demineralized enamel and the use of enamel microabrasion and bleaching for esthetics. *Semin Orthod*. 2008;14:220–225.
13. Segura A, Donly KJ, Wefel JS. The effects of microabrasion on demineralization inhibition of enamel surfaces. *Quintessence Int*. 1997a;28:463–466.
14. Segura A, Donly KJ, Wefel JS, Drake D. Effect of enamel microabrasion on bacterial colonization. *Am J Dent*. 1997b;10:272–274.
15. Croll TP, Helpin ML. Enamel microabrasion: a new approach. *J Esthet Dent*. 2000;12:64–71.
16. Waggoner WF, Johnston WM, Schumann S, Schikowski E. Microabrasion of human enamel *in vitro* using hydrochloric acid and pumice. *Pediatr Dent*. 1989;11:319–323.
17. Paul SJ, Peter A, Rodoni L, Pietrobon N. Conventional visual vs spectrophotometric shade taking for porcelain-fused-to-metal crowns: a clinical comparison. *Int J Periodontics Restorative Dent*. 2004;24:222–231.
18. Khurana R, Tredwin CJ, Weisbloom M, Moles DR. A clinical evaluation of the individual repeatability of three commercially available colour measuring devices. *Br Dent J*. 2007;203:675–680.
19. Kielbassa AM, Beheim-Schwarzbach NJ, Neumann K, Nat R, Zantner C. *In vitro* comparison of visual and computer-aided pre- and post-tooth shade determination using various home bleaching procedures. *J Prosthet Dent*. 2009;101:92–100.
20. Um CM, Ruyter IE. Staining of resin-based veneering materials with coffee and tea. *Quintessence Int*. 1991;22:377–386.
21. Johnston WM, Kao EC. Assessment of appearance match by visual observation and clinical colorimetry. *J Dent Res*. 1989;68:819–822.
22. Ruyter IE, Nilner K, Moller B. Color stability of dental composite resin materials for crown and bridge veneers. *Dent Mater*. 1987;3:246–251.
23. Paic M, Sener B, Schug J, Schmidlin PR. Effects of microabrasion on substance loss, surface roughness, and colorimetric changes on enamel *in vitro*. *Quintessence Int*. 2008;39:517–522.