Case report

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Application of quantitative light-induced fluorescence to determine the depth of demineralization of dental fluorosis in enamel microabrasion: a case report

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Enamel microabrasion has become accepted as a conservative, nonrestorative method of removing intrinsic and superficial dysmineralization defects from dental fluorosis, restoring esthetics with minimal loss of enamel. However, it can be difficult to determine if restoration is necessary in dental fluorosis, because the lesion depth is often not easily recognized. This case report presents a method for analysis of enamel hypoplasia that uses quantitative light-induced fluorescence (QLF) followed by a combination of enamel microabrasion with carbamide peroxide home bleaching. We describe the utility of QLF when selecting a conservative treatment plan and confirming treatment efficacy. In this case, the treatment plan was based on QLF analysis, and the selected combination treatment of microabrasion and bleaching had good results. (*Restor Dent Endod* 2016;41(3):225-230)

Key words: Dental fluorosis; Microabrasion; Quantitative light-induced fluorescence (QLF)

Introduction

Dental fluorosis is caused by excessive fluoride exposure during tooth development.[1] It is characterized by the presence of diffuse, thin, horizontal white striations on numerous teeth. Management of dental fluorosis is important for esthetics, and several techniques have been proposed to improve its appearance. Conventional methods are bleaching and microabrasion, composite resin restoration, and prosthetic approaches. Recently, resin infiltration has become a popular technique for management of dental fluorosis.[2] However, among groups with differing extent of demineralization there was no difference in the effect of resin infiltration on color or hardness.[3] Lastly, the tooth jewelry technique can also be used to treat dental fluorosis.[4]

Enamel microabrasion has become accepted as a conservative, nonrestorative method of removing intrinsic and superficial dysmineralization defects from teeth, establishing esthetics with minimal loss of enamel. However, it is often difficult to determine if restoration is necessary in enamel hypoplasia, because the lesion depth is difficult to recognize. There are many *in vitro* methods for assessing lesion depth, such as microhardness indentation, sectioning, and scanning electron microscope examination. *In vivo*, there are no methods for assessing lesion depth, and only conventional methods for detecting enamel hypoplasia exist, such as ultrasound, transillumination, and visual inspection of changes.

A quantitative light-induced fluorescence (QLF) device allows the quantification of

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mineral loss from enamel in the laboratory and in clinical situations for early detection of dental caries (Figure 1).[5] When illuminated with blue light (405 nm), tooth enamel produces green auto-fluorescence. The absolute decrease in fluorescence as a result of enamel loss is determined by calculating the percentage loss between actual and reconstructed fluorescence and is expressed by ΔF.

QLF is a user-friendly, reproducible, and reliable method of quantifying mineral loss from enamel.[6] However, case reports of QLF treatment of dental fluorosis are few. The following case report describes the utility of QLF when developing a conservative treatment plan and confirming treatment results.

Case Report

An 18 year old woman with a non-remarkable medical history presented to the Department of Conservative Dentistry, Chosun University Dental Hospital for removal of white spot lesions on the labial surface of the anterior incisors (Figure 2). The patient's dental history included reduction of the right temporomandibular joint due to anterior disc displacement. An intraoral examination showed diffuse white horizontal striations on all dentition except the lower anterior teeth. While the enamel opacity was diffuse, there was no clear boundary with the adjacent normal enamel. No specific features were found on diagnostic radiographs. After clinical and radiologic examination, the white spots were diagnosed as dental fluorosis.

In order to determine the depth of this lesion, the white spots on the anterior upper teeth were analyzed by QLF (Inspektor Research Systems BV, Amsterdam, Netherlands). Table 1 and Figure 3 present the results of the QLF analysis. Based on the QLF results, the treatment options, including microabrasion and home bleaching, were explained to the patient. After obtaining informed consent, a decision was made to perform microabrasion with Opalustre (Ultradent Products, Inc., South Jordan, UT, USA) and home bleaching with Opalescence (Ultradent Products, Inc.) on six maxillary anterior teeth. The materials used are described further in Table 2.

Figure 1. The QLF device is based on a DSLR camera equipped with an illumination tube with white and blue light-emitting diodes positioned in a ring around the lens opening. QLF, quantitative light-induced fluorescence; DSLR, digital single lens reflex.

Figure 2. Initial photograph from the first examination showing white spots on the upper dentition.

Table 1. Results of QLF analysis before treatment

	Right maxillary lateral incisor	Right maxillary central incisor	Left maxillary central incisor	Left maxillary lateral incisor
ΔF	-7.5%	-5.1%	-10%	-6.2%
ΔFmax	-11%	-5%	-19%	-7%
Area	36 px^2	2 px^2	296 px^2	4 px^2

QLF, quantitative light-induced fluorescence; ΔF, average lesion depth; ΔFmax, maximum lesion depth; px, pixels.

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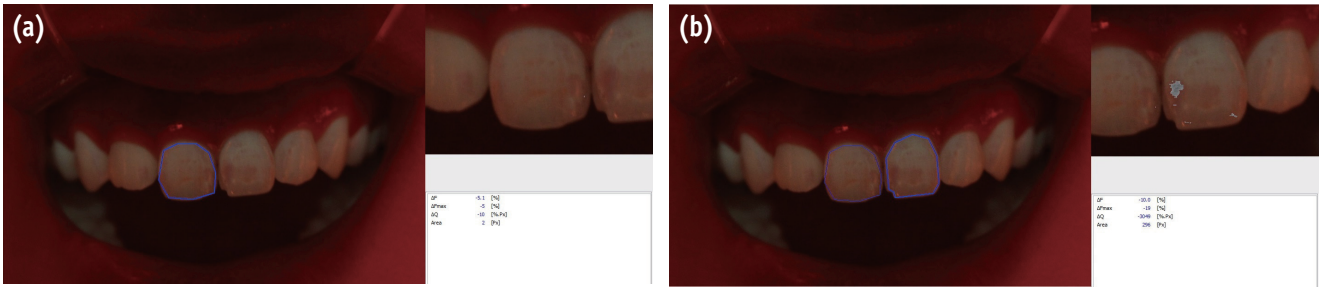

Figure 3. Results of QLF analysis before treatment. (a) Right maxillary central incisor; (b) Left maxillary central incisor. QLF, quantitative light-induced fluorescence.

Table 2. Materials used in this case

Material	Component	Manufacturer
Opalustre	Opalustre syringe: 6.6% hydrochloric acid, 20 - 160 μm silicon carbide microparticles OpalCups bristle	Ultradent Products, Inc., South Jordan, UT, USA
Opalescence	10% carbamide peroxide	Ultradent Products, Inc., South Jordan, UT, USA

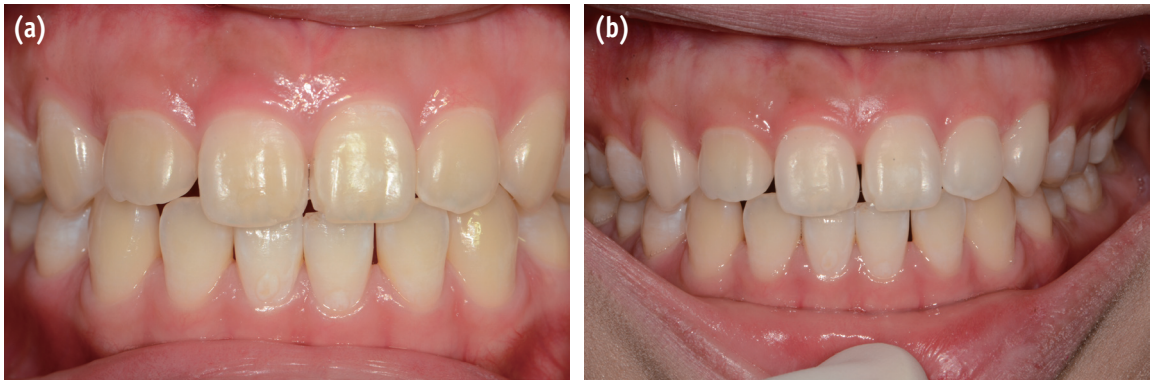

Figure 4. Photograph taken after treatment showing improved esthetics of the upper dentition. (a) Intraoral photograph after microabrasion; (b) Intraoral photograph after home bleaching.

After OpalDam (Ultradent Products, Inc.) and a rubber dam were applied, microabrasion was performed. In brief, the teeth were cleaned with pumice and water using a rubber cup in a slow speed contra-angle handpiece. The slurry was applied to the labial surface of each tooth with a small wooden toothpick. The rubber cup was used in 20 second applications, each applying no more than 10 g of force and repeated 10 times. The teeth looked yellowish and the white spots became less prominent than before abrasion (Figure 4). The assessment of tooth color using a commercial shade guide system was A3. Home bleaching was performed using individual trays for four weeks. The tooth shade became similar to the other teeth and the few remaining white spots were masked by the bleaching effect. After bleaching, the tooth shade was assessed as A1.

After treatment, the QLF analysis was repeated (Table 3). The results showed that the white spots had almost disappeared (Figure 5). Finally, a composite resin restoration with Charisma Diamond (Heraeus Kulzer, Hanau, Germany) was performed on the mesial enamel fracture of the left central incisor with OL (opaque light) and A1 shade (Figure 6). The patient was satisfied with the result. Therefore, treatment was considered complete.

Table 3. Results of QLF analysis after treatment

	Right maxillary lateral incisor	Right maxillary central incisor	Left maxillary central incisor	Left maxillary lateral incisor
ΔF	0%	0%	0%	0%
ΔFmax	0%	0%	0%	0%
Area	0 px^2	0 px^2	0 px^2	0 px^2

QLF, quantitative light-induced fluorescence; ΔF, average lesion depth; ΔFmax, maximum lesion depth; px, pixels.

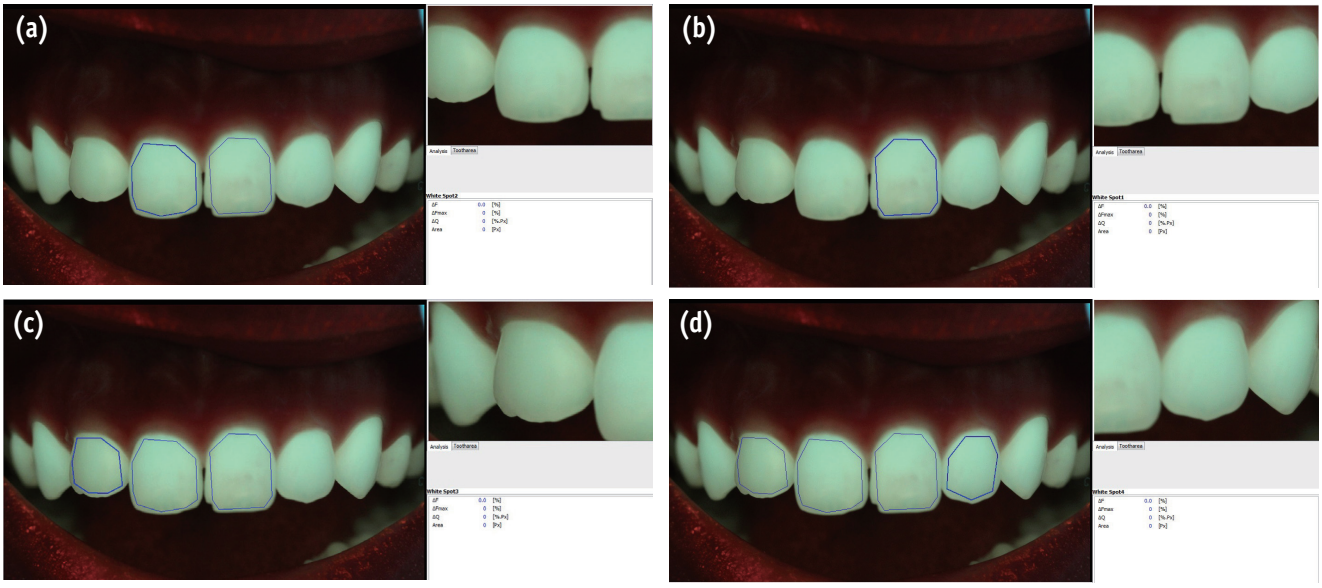

Figure 5. Results of QLF analysis after treatment. (a) Right maxillary central incisor; (b) Left maxillary central incisor; (c) Right maxillary lateral incisor; (d) Left maxillary lateral incisor. QLF, quantitative light-induced fluorescence.

Figure 6. Photograph of maxillary lateral incisors after completion of the treatment with composite restoration of left central incisor.

Discussion

The QLF device used was the QLF-D Biluminator (Inspektor Research Systems BV), a new type of QLF device (Figure 1). Fluorescence images were captured with a digital single lens reflex (DSLR) camera (model 550D, Canon, Tokyo, Japan) with a shutter speed of 1/45 second, aperture value of 3.2, and ISO speed of 1600. Proprietary software (C3 v1.18, Inspektor Research Systems BV) was used to store all digital images on a personal computer. All fluorescence images were analyzed using a computer program (QA2 v1.18, Inspektor Research Systems BV) that measured the white spot patch.

Within the images, a reference is automatically generated or manually selected. A value is computed for each pixel in

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the area of interest. These pixel values are then compared to the average value of all pixels in the reference area. This permits the calculation of area size and average value over the area as a function of a threshold value. Delta F (ΔF) means percent loss of fluorescence with respect to the fluorescence of sound tooth tissue. This value is related to lesion depth. Kim *et al*. showed that ΔF was strongly correlated with histological lesion depth before and after fluoride treatment.[7] Recently, Nakata *et al*. reported a good correlation between each ΔF value and the demineralization depth,[8] such that when the demineralization depth increased, the ΔF value decreased. These authors suggested that at a ΔF value of 25%, the demineralization depth is around 200 μm. Wu *et al*. also reported a linear correlation between the percent loss of fluorescence and depth of the enamel demineralization.[9] The greatest depth data on demineralization and the highest percentage loss of fluorescence were obtained; when the fluorescence loss value was 25%, the largest caries depth was 77 μm.

In the present case, the ΔF was less than 10% and the maximum ΔF was 19%, suggesting that the white spot lesion depth might be less than 200 μm according to the findings described above. Therefore, microabrasion and bleaching were selected for treatment. Microabrasion has been reported to reduce white spot lesions with 83% success,[10] and can remove 200 μm of superficial enamel.[11] The precise amount of enamel removed by microabrasion has been estimated using scanning electron microscopy,[12] digital micrometry,[13] and profilometry[14] to be an amount not exceeding 250 μm. Bleaching of teeth is efficient in masking blemishes and providing a more uniform appearance.[15,16]

There are limited ways to recognize the depth of white spot lesions and then decide on conservative treatment methods. Microabrasion is a conservative method, but when the lesion is deeper than 250 μm, the enamel loss is too much and the microabrasion efficacy is decreased. QLF is a diagnostic device for detecting early caries, as it can analyze white spot lesions and help with evaluating the limitations of microabrasion. If the ΔF value is greater than 25%, an invasive treatment plan using composite resin restoration or prosthetic approaches is necessary. In this case, QLF was used successfully to determine the treatment planning. However, QLF also has several limitations. First, it has not yet been used in interproximal lesion. Secondly, analysis of lesions is possible with QLF, but the results depend entirely on the operator. Additional software development will allow the application of the method to interproximal lesions. Further studies are necessary to adjust the method to be suitable for evaluating baseline lesion depth and assisting in deciding whether to apply the resin infiltration technique or microabrasion.

Conclusions

In this case, the combination treatment plan of microabrasion and bleaching, based on QLF analysis, had a good result. Therefore, QLF analysis may help when deciding on conservative treatment plans and also confirm treatment results.

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Conflict of Interest: No potential conflict of interest relevant to this article was reported.

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