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Color Masking White Fluorotic Spots by Resin Infiltration and Its Quantitation by Computerized Photographic Analysis: A 12-month Follow-up Study

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Clinical Relevance

Mild to moderate fluorosis spots can be satisfactorily masked by combining a bleaching and resin infiltration technique, quantitation of which can be done by a simple technique of color analysis of photographs using Adobe Photoshop software.

SUMMARY

Objective: To manage three cases of mild to moderate fluorosis by resin infiltration technique and to quantify the tooth color changes by measuring CIE L*a*b* values of digital photographs and calculating ΔE_{00} based on the CIEDE2000 formula using Adobe Photoshop software.

Methods and Materials: Three cases of mild to moderate fluorosis were treated with a combination of bleaching and a resin infiltration technique. CIE L*a*b* values of 18 fluorosed spots were measured from digital photographs of these cases at four different stages—preoperative, postbleaching, postinfiltration and at 12-month follow-up—using Adobe Photoshop software, and ΔE_{00} was calculated based on the CIEDE2000 formula. The ΔE_{00} values of all 18 points obtained at different stages were submitted to statistical analysis (α=0.05)

Results: In all the cases reported, clinically as well as by the photographic color analysis, it was found that the technique masked the lesions, improving the patients' esthetics, which was maintained even at 12-month recall. Statistically significant difference in ΔE_{00} values was present between comparison of all stages ($p<0.001$) except between postinfiltration and the 12-month follow-up stage ($p=0.642$).

Conclusion: A resin infiltration technique helped in the satisfactory management of white spot lesions of fluorosis, which were

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stable even at 12-month follow up. Quantitation of the changes was achieved using Adobe Photoshop software.

INTRODUCTION

Patients often present to dentists with a demand to improve the esthetic appearance of their teeth. Most of them want their teeth to be lightened, but a few also want to darken the white spots present on their teeth.

White spots on teeth can be due either to preeruptive causes, such as fluorosis, traumatic hypomineralization, or molar incisive hypoplasia, or to posteruptive causes, such as demineralization caused by caries and the accumulation of plaque or cementation of orthodontic brackets. Among these, white spot lesions (WSLs) of fluorosis are the most common.[1,2] These are developmental, hypoplastic, and hypomineralized subsurface areas in enamel formed during periods of excessive fluoride exposure during the maturation stage of amelogenesis wherein the matrix protein amelogenin is not completely egressed, impeding complete growth of hydroxyapatite crystals. When fluoride reverts to normal levels, enamel formation also reverts to normal structure. However, the surface enamel is always hypermineralized, as there is a continuous exchange of ions, such as calcium, phosphate, and fluoride, with the oral environment.[3]

The refractive index (RI) of hydroxyapatite is 1.62, that of water/organic content/ethanol is 1.33, and that of air is 1.[4] Healthy enamel is made up of 96% inorganic (hydroxyapatite) and 4% organic content and is almost homogeneous. As most of it is hydroxyapatite; it acts as a single medium, allowing most light to be transmitted through it to the underlying dentin, which absorbs a major portion of it, imparting color to the tooth. However, in fluorotic teeth, the areas of hypomineralized enamel (WSL) are interspersed in normal mineralized enamel. As WSLs have both mineral and organic content, the light is deflected multiple times at their interface, resulting in a scattering of light in multiple directions. Very little to no light reaches the dentin, thus the dentin imparts no color to the area and the lesions appear white clinically. The scattering coefficient of light increases by a power of three[5] with an increase in demineralization, and thus all light is scattered in the well-defined WSLs; however, in diffuse WSLs with no definite borders and less demineralization, some wavelengths of light reach the dentin, giving some color.[4,6]

Various invasive procedures, such as microabrasion, resin composite restorations, veneers, and even full crowns, have been suggested for the management of these WSLs,[1] of which microabrasion was considered to be the minimally invasive technique. It gave satisfactory results for shallow lesions, but for deeper lesions, there may be substantial removal of enamel (360 ± 130 μm when rubbed 20 times with an 18% HCl and pumice mixture)[7] resulting in irregularities or surface defects that may reinvite staining.

In 2009, the concept of resin infiltration was developed in Charite Berlin by two developers—Dr H. Meyer-Luckel and Dr Sebastian Paris—for the treatment of incipient, hypomineralized, porous, opaque white, noncavitated carious lesions.[8] The product is marketed as Icon (DMG America, Englewood, NJ, USA), containing a low-viscosity resin that is infiltrated into porous enamel, replacing air/water, occluding diffusion pathways for acids and dissolved materials, increasing the hardness of enamel, and preventing further progress of caries. The additional advantage is the blending of the white color of the carious lesion with sound adjacent enamel (SAE), as the difference between RIs of air/water and enamel is nearly eliminated by infiltrating resin (RI=1.52). By the same theory, it has been hypothesized that the WSLs of fluorosis, which are also hypomineralized areas, can be managed by the infiltration technique in the most conservative way. Numerous *in vitro* studies[4,6,8] and case reports have been published showing the effectiveness of the technique in the management of hypocalcified lesions of initial caries[9,10] and orthodontic bracket cementation–induced white spots[11,12] as well as those of fluorosis.[13-15] Quantitation of color changes of orthodontic white spots managed by this technique has been reported,[10,11] but none has been reported in WSLs of fluorosis. Moreover, there is limited information about the long-term stability of color masking achieved in these lesions.

Posttherapeutic color difference can be assessed in many ways, such as by visual assessment (photographs or shade tabs), instruments (colorimeter or spectrophotometer), and digital photographic analysis. The results judged by visual assessment of photographs and shade guides are highly subjective and variable. But color assessment done by colorimeter, spectrophotometer as well as the digital photographic analysis done by Adobe Photoshop software provide numeric values, making the method objective, quantitative, reproducible, and analyzable statistically. They all use the color system developed by Commission Internationale de l'Eclairage (CIE) involving three parameters to define color: L* (lightness), a* (red/green chromaticity), and b* (yellow/blue chromaticity). It is currently the most popular color system used for dental purposes. However, the use of instruments to measure tooth color *in vivo* is difficult (they are designed to measure flat surfaces), cumbersome, expensive, and not readily available everywhere, whereas digital photographic analysis by image editing software like Adobe Photoshop as described by Bengel[16] is relatively simple, easily available, and cheap. It has been used for the evaluation of color changes of bleached teeth.[16,17]

The purpose of this study was to describe the management of three cases of mild to moderate fluorosis by the resin infiltration technique and to evaluate the color change by visual assessment of photographs and by digital photographic analysis with the help of Adobe Photoshop CS5 software (Adobe Systems Inc, San Jose, CA, USA) using CIE L*a*b* color space by calculating the color difference delta E (ΔE) between healthy and abnormal enamel with the CIEDE2000 formula and comparing values obtained at various stages. ΔE is defined as the Euclidean distance in three-dimensional color space (L*, a*, b*) between two different points.

METHODS AND MATERIALS

Three patients, ages 18, 23, and 24 years, reported to the Government Dental College and Hospital with the esthetic concern of remarkably perceptible white spots and a few light brown spots in maxillary anterior teeth.

The patients' histories revealed them to be born in areas known to be fluoridated, and on clinical examination, the white to light brown stains with intact smooth enamel surfaces were diagnosed as moderate fluorosis, so the patients were included in the study. WSLs in the first two cases were well defined and in the third case were diffuse. As the dark spots (DS) were also present, bleaching followed by resin infiltration with Icon for all maxillary anterior teeth was planned after approval from the institute's ethical committee.

Clinical Intervention

After prophylactic scaling, in-office bleaching with chemically activated Pola Office Plus (SDI, Victoria, Australia) was done according to the manufacturer's instructions in a single visit. Three applications of gel, each for eight minutes without rinsing (only suctioning in between), were done. As nascent oxygen is released during the bleaching procedure, interfering with the polymerization of resin, a 10-day waiting period was observed before resin infiltration.[18]

The infiltration procedure was carried out following the manufacturer's instructions. Each kit for each patient was comprised of three syringes: 15% hydrochloric acid gel (Icon etch, 0.45 mL), ethanol (Icon dry, 0.45 mL), and resin infiltrant 99% triethylene glycol dimethacrylate (TEGDMA[19] [Icon, infiltrant, 0.45 mL]). Following prophylactic polishing with rubber cups (Kerr Corp, Orange, CA, USA), rubber dam (Dental Dam, Coltene Whaledent, Langenau, Germany) isolation was done. To access the subsurface hypomineralized area, Icon etch (15% hydrochloric acid [HCl]) was applied for 120 seconds, rinsed with distilled water for 30 seconds, and air-dried. Then Icon dry (ethanol) was applied for 30 seconds, which changes the RI of enamel. The whiteness of the lesions should have diminished or disappeared; if it did not, it implied the inaccessibility of the lesion to ethanol and subsequently to the resin. Therefore, the sequence of etching and ethanol application was repeated until the whiteness of the spots disappeared (maximum of three times).[14,20]

Next, resin infiltrant was applied with an applicator tip, allowed to penetrate for three minutes, and polymerized for 40 seconds (500 mW/cm^2, Bluephase C5 light, Ivoclar Vivadent, Schaan, Liechtenstein), followed by a second infiltration for one minute, which was done to compensate for the polymerization shrinkage of the first application. Finishing and polishing were done with fine-graded abrasive flexible discs, finishing strips, and rubber cups (Swiss Flex, Coltene Whaledent).

Digital front-view photographs (Coolpix S7000 camera, Nikon, Shinagawa, Japan; macro-lens F/3.4, with camera settings of focal length of 4 mm, maximum aperture of 3.5, no flash, and auto white balance) were taken at four stages—preoperative, postbleaching, postresin infiltration, and at 12-month follow-up—and assessed visually (Figures 1 through 3) as well as with the image editing Adobe Photoshop software (Figure 4). At every stage, the patient position and the distance of the patient from the lens were maintained. The patients were positioned such that the maxillary central incisors were in the plane of focus. Although it is difficult to completely standardize the ambient light, efforts were made by excluding daylight and keeping 16 light tubes constant throughout the procedures in the room where the examination took place.[21] The teeth were kept wet with saliva and water to prevent

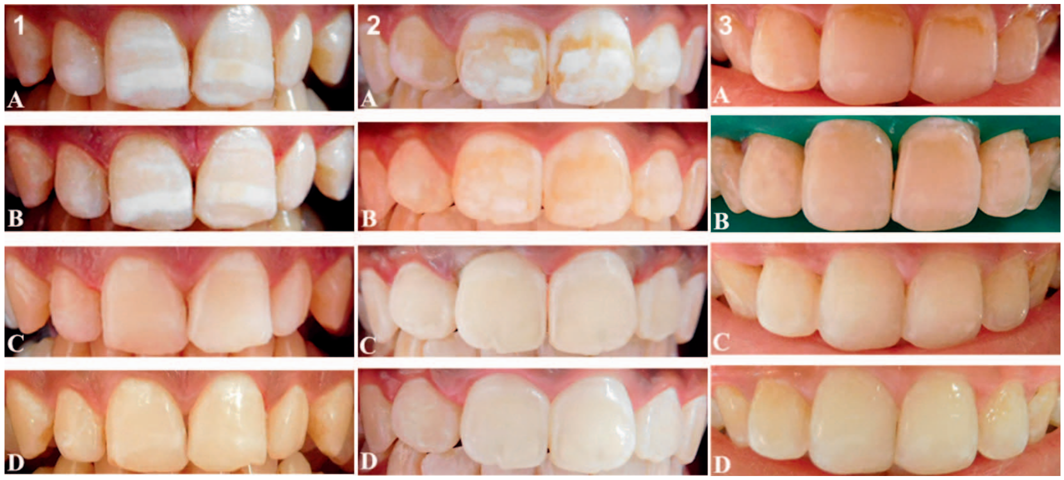


Figure 1. *Case 1. (A): Preoperative. (B): Postbleaching. (C): Immediate postinfiltrative. (D): 12-month follow-up.*

Figure 2. *Case 2. (A): Preoperative. (B): Postbleaching. (C): Immediate postinfiltrative. (D): 12-month follow-up.*

Figure 3. *Case 3. (A): Preoperative. (B): Postbleaching. (C): Immediate postinfiltrative. (D): 12-month follow-up.*

the color alterations caused by the dehydration of teeth. All the clinical procedures, photography, and quantitation of color changes were done by the same operator.

Photographic Analysis

Analysis of images was done by modifying the method described by Bengel.[16] Only central incisors of each case were evaluated. First, the photographs of the case captured at all four stages were opened in Adobe Photoshop CS5 ("Ctrl+O"). "View>show> grid" was used to superimpose a grid on the photographs. "Edit>preferences>guides, grids, and slices>grid line every" was chosen, and values of 10 mm and 5 were input into the "gridline every" and "subdivision," respectively, to change the size of the grid to 2 × 2 mm. Thereafter, the layer panel was made visible (F7 shortcut), and the layers were

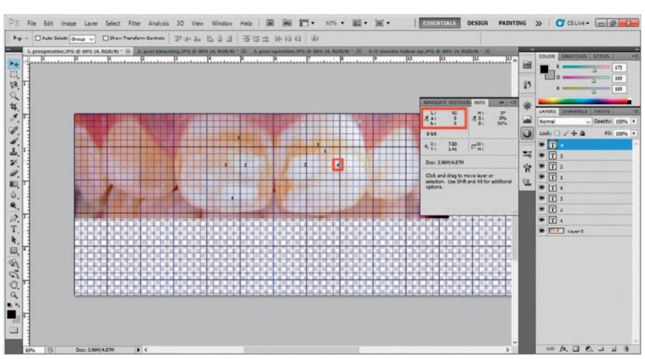


Figure 4. *Screenshot of Adobe Photoshop software showing different points marked in central incisors of case 2. Inset box shows the measured L*, a*, and b* values of point 4 of tooth 9.*

unlocked by double-clicking the lock symbol to right of the "background." Ctrl + T was selected to open the "resize" dialog box, and keeping the Shift key pressed, the corner of the image was dragged to change the size, and then the right check mark on the right upper corner was clicked to finalize the size. Following the above steps, all the photographs of the same case were resized to the same size taking reference of the superimposed grid. Errors of ambient light standardization and its influence on color can be minimized but cannot be eliminated. Thus, photographs of different stages may vary in lighting conditions, which is eliminated by the use of gray card in various studies[16,17,21] (as described by Bengel[16]). However, as it is not readily available in general dental clinics, it was not used here; instead, the method was modified, and the areas of SAE were compared with WSL/DS in the same photograph where the lighting conditions would have been the same. One point of SAE and three points of fluorosed spots (WSL and DS) were selected on each central incisor, and thus a total of 3 (fluorosed spots) × 6 (central incisors) = 18 abnormal points were evaluated. From the "windows" menu, the "info" tab was selected (F8 shortcut), and the pointer was moved to these points to obtain the *x* and *y* coordinates and CIE L*a*b* values. However, variables such as tooth texture, contours, and varying thickness of enamel make CIE L*a*b* values of even SAE different at various points in the same photograph. Hence, to compare ΔE values (color difference between SAE and each WSL/DS) at different stages of treatment, the points selected in the preoperative photographs

Table 1: *L*, a*, and b* Values Obtained for Central Incisors at Different Stages of Treatment*

Stages	Case 1								Case 2								Case 3							
	Tooth 8				Tooth 9				Tooth 8				Tooth 9				Tooth 8				Tooth 9			
	1 SAE	2 W	3 W	4 W	1 SAE	2 W	3 D	4 W	1 SAE	2 W	3 D	4 W	1 SAE	2 W	3 D	4 W	1 SAE	2 D	3 W	4 D	1 SAE	2 D	3 W	4 D
L*																								
A	74	85	86	83	80	87	83	89	76	86	67	87	82	89	75	92	62	54	71	56	64	63	65	57
B	79	88	91	87	86	89	90	90	82	86	80	89	81	81	79	84	68	65	74	67	70	69	74	67
C	79	78	77	77	82	81	84	81	84	83	82	84	83	84	83	84	74	74	74	74	73	71	74	71
D	84	84	84	85	85	84	87	85	82	82	81	82	87	86	86	89	77	75	75	74	79	80	79	79
a*																								
A	5	0	0	0	1	0	2	0	5	0	8	0	2	0	6	0	18	25	16	24	17	17	16	21
B	5	0	0	1	1	1	2	2	8	5	9	5	9	10	12	7	15	17	11	15	14	12	10	12
C	10	11	10	9	6	7	6	6	3	4	4	3	3	4	3	2	9	9	7	10	9	12	7	10
D	5	4	3	3	3	3	2	2	2	3	3	2	2	2	2	1	3	5	2	7	2	1	1	2
b*																								
A	9	0	0	0	8	0	13	0	14	0	29	0	22	0	40	0	27	43	16	41	24	30	19	37
B	10	0	0	1	9	2	6	4	22	12	23	6	28	24	31	19	21	29	18	27	21	26	17	29
C	18	19	18	19	15	14	16	12	12	12	13	12	11	11	13	11	21	23	19	25	19	22	16	22
D	21	22	20	19	21	20	18	19	11	10	10	10	8	10	9	7	21	24	18	26	19	20	16	22

Abbreviations: SAE, sound adjacent enamel; W, white spot lesion; D, dark spots; A, preoperative; B, postbleaching; C, postinfiltrative; D, 12-month follow-up.

were precisely relocated in the subsequent stage photographs with the reference of x and y coordinates.

ΔE was calculated by the CIEDE2000 formula using an online delta E calculator (http://www.colormine.org/delta-e-calculator/Cie2000).

$$\Delta E_{00} = \sqrt{\left(\frac{\Delta L'}{K_L S_L}\right)^2 + \left(\frac{\Delta C'}{K_C S_C}\right)^2 + \left(\frac{\Delta H'}{K_H S_H}\right)^2 + R_T\left(\frac{\Delta C'}{K_C S_C}\right)^2\left(\frac{\Delta H'}{K_H S_H}\right)^2}$$

Statistical Analysis

ΔE_{00} values at various evaluation periods were compared by a paired t-test at a 95% confidence interval and a 5% significance level using SPSS version 23 software.

RESULTS

Subjective Color Evaluation

From the clinical perspective and visual assessment of photographs, masking of WSLs as well as DS immediately following resin infiltration was achieved in all the cases, which remained stable even at 12-month recall (Figures 1 through 3).

Objective Color Evaluation

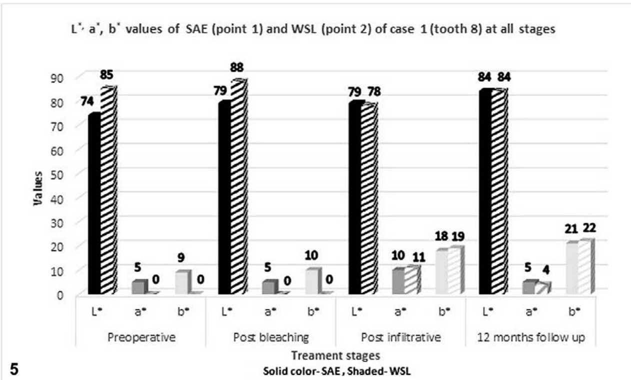
The preoperative, postbleaching, postinfiltrative, and 12-month recall values of all three components of color of the selected spots obtained by the color analysis of images are shown in Table 1. The graphical presentation of comparison of values of one of the WSL with SAE is shown in Figure 5. Table 2 shows the ΔE values of all the spots, and Figure 6 shows the graphical presentation of the changes in ΔE values at various stages.

Table 3 shows the statistical comparison of ΔE values between each stage. A highly statistically significant difference is seen between preoperative and each of the interventional stages (ie, bleaching and postinfiltration stage [$p<0.001$]), indicating an improvement in the appearance of teeth with the treatment, except between the postinfiltration and 12-month follow-up stage ($p=0.642$), which is suggestive of the stability of the result.

DISCUSSION

Various acids, such as 37% phosphoric acid (readily available in a dental office) and 5% HCl, have been tried for removal of the hypermineralized surface layer of enamel (~30 to 50 μm thick), but they were found to etch to a depth of only 7 to 10 μm.[7] Therefore, a stronger acid, such as 15% HCl, is recommended, which, when rubbed for 120 seconds, etches enamel to a depth of about 34.02 μm, and when its application time is increased to four, six, and eight minutes, it etches to a mean depth of 49, 66 and 79 μm, respectively.[22]

For infiltrating the WSLs, various resin adhesives having RIs similar to enamel have been tried, but they have shown limited depth of penetration[23] and



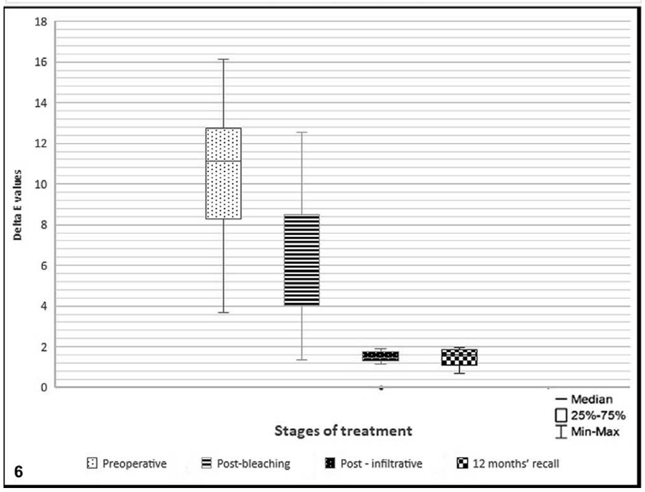


Figure 5. *Graphical representation of comparison of changes in L*, a*, and b* values of SAE (point 1) and WSL (point 2) of case 1(tooth 8) at different stages.*

Figure 6. *Median, interquartile range, and minimum and maximum values of ΔE at various stages of treatment. The high preoperative ΔE values decrease in subsequent stages of treatment.*

have been found to be ineffective.[24] According to Washburn's[25] equation, the penetration coefficient (PC), which describes the penetration of liquids into porous solids, the higher the PC (of light-curing resins) and the longer the application time (within limits), the deeper the penetration in a given porous bed (enamel). The PC of 90% bisphenol A glycidyl methacrylate (BISGMA), 90% diurethane dimethacrylate (UDMA), 100% 2-hydroxyethyl methacrylate (HEMA), and 100% TEGDMA were found to be 0.2, 3.6, 326.8 and 204.1 cm/s, respectively.[26] Although higher PC was observed in 100% HEMA as compared to TEGDMA, the higher content of HEMA resulted in imperfect hardening on curing and therefore was not chosen. Presently, considering all the above factors, TEGDMA seems to be the most optimum resin for infiltration.

A study[19] on the effect of application time has shown that the optimum benefit of penetration could be obtained in three minutes to a depth of 395 to 640 μm. Application time of more than three minutes did not increase the penetration depth, but penetration depth was less when the time was less than three minutes. Therefore, it can also be inferred that only WSLs of approximate depth less than 640 μm can be infiltrated with resins, explaining its inability to mask the deeper ones.

The aim of the treatment is to make the color and value of white spots similar to those of SAE and make ΔE values close to zero. ΔE was calculated using the CIEDE2000 (ΔE_{00}) formula, which provides a higher degree of fit and is an update of the previous formula, adjusting both for the nonuniformity of the CIELAB space and for differences in illuminating conditions.

There is no consensus for the perceptibility and acceptability thresholds of ΔE values. Values as high as 3.7 have been proposed as the acceptance limit in most studies.[21,23,27] But to increase the sensitivity and decrease the probability of missing clinically visible differences, we used the lower values given in a recent study,[28] that is, ΔE_{00} less than 0.8 (clinically perceptible), between 0.8 and 1.8 (clinically perceptible but acceptable), and beyond 1.8 (not acceptable).

Healthy enamel (SAE) has some values for all three components of color: L, a*, and b*. In preoperative photographs, L* values of WSLs in all the cases were more than SAE, the difference being more pronounced in well-defined WSLs (cases 1 and 2) than in the diffuse lesions (case 3); a* and b* values were less in diffuse ones but were zero in well-defined ones (Table 1). ΔE_{00} values of all the spots were in the unacceptable range of 3.70 to 15.49.

After bleaching, there was a generalized lightening of the teeth with an increase in L* values ($p<0.001$). The difference between WSL and SAE also decreased as the striking whiteness of WSL with its surrounding enamel decreased. For the DS, the b* values decreased (decrease in pigment saturation of the spots) but not close to SAE. ΔE_{00} for both decreased but not to an acceptable range. Moreover, the WSLs did not disappear, as their masking requires exactly the opposite effect, namely, a decrease in L* and an increase in b*,[29] which was observed only post resin infiltration (Table 1).

Immediately after infiltration, due to changes in the RI and the transmission of light to the underlying dentin, the whiteness of the WSL disappeared (decrease in L*), and the real tooth color, which was hidden beneath, reappeared (increase in b*). There

Table 2: *ΔE Values (Color Difference Between WSL/DS and SAE)*[a]

	Case 1						Case 2						Case 3					
	Tooth 8			Tooth 9			Tooth 8			Tooth 9			Tooth 8			Tooth 9		
	2 W	3 W	4 W	2 D	3 W	4 W	2 D	3 W	4 W	2 D	3 W	4 W	2 D	3 W	4 D	2 D	3 W	4 D
Preoperative	12.01	12.44	11.22	8.31	4.09	9.09	13.54	8.99	13.88	15.49	8.30	16.14	11.04	11.50	9.83	3.70	4.42	11.87
Post bleaching	11.45	12.54	9.79	5.98	3.79	4.99	6.44	1.36	11.03	2.67	4.1	5.79	6.40	5.51	2.24	4.47	4.87	8.06
Post - infiltrative	1.13	1.41	1.92	1.53	1.50	1.73	1.43	1.90	**0**	1.40	1.33	1.44	1.50	1.55	1.29	1.20	1.90	1.90
12 months' recall	1.48	1.74	1.45	**0.79**	1.85	1.84	1.60	1.74	**0.69**	1.56	0.97	1.12	1.88	1.95	1.06	1.52	1.97	1.61

Abbreviations: W, white spot lesion; D, dark spots.
[a]: White box: $\Delta E_{00} \leq 0.8$, not perceptible clinically; gray box: $\Delta E_{00} \geq 0.8$ and <1.8, clinically perceptible but acceptable; graphite gray box ; black box, $\Delta E_{00} \geq 1.8$, not acceptable. Note all the unacceptable values (black box) turning acceptable (gray box) at the postinfiltrative stage and three unacceptable points (graphite gray box) turning acceptable (gray box) at the 12-month recall.

was an increase in a* values also, but it has little influence on color change.[27,30] The DS also (which are hypomineralized as well) probably got infiltrated with resin and thus merged with the surrounding tooth structure.

Out of the 18 points (11 WSLs and seven DSs) evaluated, ΔE_{00} values for 14 were found in the acceptable range, and the result was found to be highly significant statistically as compared to the preoperative and postbleaching stages ($p<0.001$). Only four points (three WSLs and one DS) had marginally higher values (1.9 [Table 2]), showing a 77% rate of success. TEGDMA in ICON is an unfilled resin having poor abrasion resistance and a higher water sorption rate and was found to have increased surface roughness and subsequent staining after thermocycling and water storage in an *in vitro* study.[31] Despite these unfavorable factors for color stability, the camouflaging effect of infiltration was stable for 13 points at 12-month recall, but one point turned into the unacceptable range with a marginal difference. Additionally, three (two WSLs and one DS) of the four unacceptable points also came down to the acceptable range, showing a success rate of 88% at 12 months and indicating improvement of color over time, which is in agreement with other studies.[1,12,14,15] Moreover, the changes in ΔE_{00} values were nonsignificant ($p=0.642$) as compared to the postinfiltration stage, validating the long-term stability of the result. As the patients were satisfied with the results achieved and felt an increase in their self-esteem, the treatment can be considered to be successful.

CONCLUSION

The resin infiltration technique has opened a new scope for the management of white spots of fluorosis in a minimally invasive manner. Quantitative color assessment by image analysis using Adobe Photoshop is a simple, easy, and promising method of color assessment. Further trials of the method with extended periods of observation and more sample size will reveal more nuances of the method.

Regulatory Statement

This study was conducted in accordance with all the provisions of the local human subjects oversight committee guidelines and policies of the institutional ethics committee of the Government Dental College and Hospital. The approval code for this study is IEC GDCH/CO.3/2017.

Table 3: *Individual Intergroup Comparison of Mean ΔE Values*[a]

Comparisons	Mean	N	Standard Deviation	Standard Error of the Mean	Mean Difference	95% Confidence Interval		p-Value
						Lower	Upper	
Pair 1								
Pretreatment	10.33	18	3.64	0.86	4.132	2.212	6.053	<0.001*
Postbleaching	6.19	18	3.22	0.76				
Pair 2								
Pretreatment	10.33	18	3.64	0.86	8.878	7.000	10.756	<0.001*
Postinfiltrative	1.45	18	0.44	0.10				
Pair 3								
Pretreatment	10.33	18	3.64	0.86	8.836	6.966	10.705	<0.001*
12-month follow-up	1.49	18	0.40	0.09				
Pair 4								
Postbleaching	6.19	18	3.22	0.76	4.746	3.057	6.434	<0.001*
Postinfiltrative	1.45	18	0.44	0.10				
Pair 5								
Postbleaching	6.19	18	3.22	0.76	4.703	3.065	6.342	<0.001*
12-month follow-up	1.49	18	0.40	0.09				
Pair 6								
Postinfiltrative	1.45	18	0.44	0.10	−0.042	−0.231	0.146	0.642 NS
12-month follow-up	1.49	18	0.40	0.09				

[a] * *highly significant* ($p<0.05$)*; NS, not significant* ($p>0.05$).

Conflict of Interest

The authors of this article certify that they have no proprietary, financial, or other personal interest of any nature or kind in any product, service, and/or company that is presented in this article.

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