Original Article

Efficacy of microabrasion and resin infiltration techniques for masking of fluorotic white spot lesions: A randomized clinical study

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Abstract

Aim: The aim of the study was to compare the esthetic treatment outcome and quantification of tooth color changes using microabrasion and resin infiltration techniques of fluorotic white spot lesions (WSLs).

Subjects and Methods: Sixty-six teeth with fluorotic small opaque white areas involving 25%–50% (very mild/mild fluorosis) of the surface were randomly assigned into two groups for microabrasion and resin infiltration techniques. To quantify tooth color changes, depicted by Delta E (DE), photographic analysis was performed using Adobe Photoshop CS5 Extended version by measuring Commission Internationale de l'Eclairage L*a*b* values of each tooth at two points, i.e. one at WSL and the other one at sound adjacent enamel.

Statistical Analysis Used: Data were analyzed with *t*-test using SPSS software version 23.

Results: L*value (decrease in whiteness) of posttreatment WSL decreased in both groups but was higher in the resin infiltration group, which was statistically significant. There were no statistically significant changes observed in a* and b* values of WSL in both groups. DE value difference of pre and postoperative was higher in the resin infiltration group, which was statistically significant which indicated the stability of color obtained by the resin infiltration group.

Conclusions: Resin infiltration technique is more efficient in the immediate elimination of fluorotic WSL than microabrasion.

Keywords: Fluorotic white spot lesions; microabrasion; resin infiltration technique

INTRODUCTION

An attractive smile is a key feature in maintaining and improving a person's esthetic appearance that requires the integration of esthetic concepts that harmonize dental composition, dental facial esthetics, and facial esthetics.[1] Dental composition includes teeth position, size, proportion, shape, and color.[2] White spot lesions (WSLs) mar the attractiveness of a smile, which may be due to various reasons such as fluorosis, incipient carious lesion, molar-incisor hypoplasia, and postorthodontic treatment. Among these, the most common cause is dental fluorosis. It is characterized by disrupted mineralization, resulting in increased enamel porosity. WSL is defined as "white opacity," which occurs as a result of subsurface enamel demineralization.[3] The appearance of WSL is an optical phenomenon caused by a subsurface tissue loss, which exaggerates on drying.[4,5] Various treatment options for the WSLs of teeth includes microabrasion, resin infiltration, composite resin or porcelain veneers, laminates, etc.[3]

Enamel microabrasion was introduced by Croll and Bullock in 1986 to improve the surface texture, remove the stains, and repair enamel decalcification.[6,7] Enamel microabrasion is a conservative treatment choice, in which

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the surface of the lesion is removed by polishing with a slurry of hydrochloric acid (HCl) and silica particles. Resin infiltration is a newer treatment option and a minimally invasive technique, yet nonpatient compliance based[8] that aimed to create a barrier inside the WSL to replace the lost mineral. In this technique, demineralization of lesion is done by the application of HCl after which 99% ethanol is used to remove the water from the pores, thereby facilitating the resin penetration.[9] This technique uses tri-ethylene-glycol di-methacrylate, a monomer with a hydrophilic nature, low viscosity, and a high penetration coefficient, which facilitates penetration into the pores of the enamel.[9,10] Hence, basically resin infiltration procedure, combines acid erosion and resin infiltration of the enamel surface. The advantage of this is that enamel lesions lose their whitish appearance when their microporosities are filled with resin and look similar to surrounding sound enamel.[11]

In the present study, microabrasion technique with 6.6% HCl with silicon carbide microparticles (Opalustre; Ultradent Products, Inc., South Jordan, UT, USA) and resin infiltration technique (ICON, DMG America, Englewood, NJ, USA) were used for masking of fluorotic WSL. The aim of the study was to compare the esthetic treatment outcome and quantification of tooth color changes using microabrasion and resin infiltration techniques of fluorotic WSLs.

Null hypothesis

There is no difference in esthetic treatment outcome of WSLs after resin infiltration and microabrasion.

SUBJECTS AND METHODS

Ethical clearance was obtained from the institutional ethical committee No. IEC GDCH/CONS.2/2021 and also CTRI approved (CTRI/2022/09/046029). A minimum sample size of 60 was determined, with a 95% confidence interval and 95% power. However, the final sample size was raised to 66 to account for a 10% dropout rate on follow-up. To prevent selection bias, simple randomization using computer randomizer (www.randomiser.org.in) was done as it maintains randomness of the assignment of a person, to a particular group.

Inclusion criteria

Teeth with small opaque white areas involving 25%–50% of the surface were selected (very mild and mild fluorosis [Dean's fluorosis index, 1942]).

Exclusion criteria

Patients who had genetically transitional or congenital structural defects in their teeth, tooth disorders, carious lesions or restorations on the anterior teeth, and prior microabrasion or whitening treatments were not included in the study.

Methodology

A total of 66 teeth were selected and divided into two groups of 33 each ($n = 33$) [Flow chart 1].

- Group 1: Microabrasion group ($n = 33$)
- Group 2: Resin infiltration group ($n = 33$)

In Group 1, after prophylactic scaling, petroleum jelly was applied on gingiva. Rubber dam (Dental Dam, Coltene Whaledent, Langenau, Germany) isolation was done. After prophylactic polishing of teeth, microabrasive (Opalustre® Ultradent Products, South Jordan, UT, USA) material of approximately 1 mm thickness is applied to the teeth. Light pressure is applied for 60–120 s with OpalCups bristle and micromotor handpiece. This procedure was repeated till the desired outcome (three times). After completion of the procedure, prophylactic polishing was done.

In Group 2, after prophylactic scaling, teeth of interest were isolated using a rubber dam. The infiltration procedure was carried out following the manufacturer's instructions. Following prophylactic polishing with rubber cups (Kerr Corp, Orange, CA, USA), Icon etch (15%) was applied for 120 s, rinsed with distilled water for 30 s, and air dried. Then, Icon dry (ethanol) was applied for 30 s. 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).[10,11] Next, resin infiltrant was applied with an applicator tip, allowed to penetrate for 3 min, and polymerized for 40 s (500 mW/cm^2, Bluephase C5 light, Ivoclar Vivadent, Schaan, Liechtenstein), followed by a second infiltration for 1 min, 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, Switzerland).

Digital front-view photographs (Canon 1500D, Shinagawa, Japan; macro-lens F/22, with camera settings of the focal length of 4 mm, maximum aperture of 3.5, shutter speed 1.125s no flash, and auto white balance) were taken at preoperative and immediate postoperative stages. Follow-up photographs were taken at 1 and 3 months. Evaluation of esthetic treatment outcome and quantification of the tooth color changes was done by photographic analysis using Adobe Photoshop Software CS5 Extended version and measuring Commission Internationale de l'Eclairage (CIE) L*a*b* values of each tooth at two points, i.e. one at WSL and the other one at sound adjacent enamel (SAE) to calculate delta E (DE) values using the CIEDE2000 formula by a DE calculator (http://www.colourmine.org/delta-e-calculator/Cie2000).[12]

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

The CIELAB, or CIE L*a*b*, color system [Figure 1a] represents the quantitative relationship of colors on three axes: L* value indicates lightness, and a* and b* are chromaticity coordinates. On the color space diagram, L* is represented on a vertical axis with values from 0 (black) to 100 (white). The a* value indicates red–green component of a color, where +a* (positive) and −a* (negative) indicate red and green values, respectively. The yellow and blue components are represented on the b* axis as +b* (positive) and −b* (negative) values, respectively. Intersecting point of the three axes represents neutral or achromatic. The distance from the central axis represents the chroma (C*) or saturation of the color. The angle on the chromaticity axes represents the hue (ho). CIE. DE is defined as the Euclidean distance in three-dimensional color space (L*, a*, and b*) between two different points.[13]

Here, DE is the color difference between WSL and SAE. For the evaluation of the treatment outcome and color stability over the period, DE was measured at preoperative, immediate postoperative, and 1- and 3-month follow-ups.[13]

RESULTS

Data were analyzed with independent *t*-test for intergroup comparison and paired *t*-test for intragroup comparison using SPSS software version 23 (IBM Corp. Released 2015. IBM SPSS Statistics for Windows, Version 23.0 Armonk, NY: IBM Corp.).

It was observed that L* value of posttreatment WSL decreased in both groups. The values were 3.29 in the resin infiltration group and 1.53 in microabrasion group, which was statistically significant. There were no significant changes observed in the a* values of WSL in both groups. b* value difference of preoperative with immediate postoperative, and 1-month comparison was higher in the resin infiltration group, but it was statistically nonsignificant.

DE value difference of pre and postoperative was higher in the resin infiltration group, which was statistically significant [Figure 1b]. DE difference of preoperative with immediate postoperative, 1-month follow-up, and 3 month follow-up were approximately constant which indicated the stability of color obtained by resin infiltration group [Figure 2 (a-d, e-h)].

DISCUSSION

One of the frequent causes of WSL is dental fluorosis, which is a developmental disturbance of enamel caused by successive exposures to high concentrations of fluoride during tooth development, and is characterized by enamel with lower mineral content and increased porosity.[14]

As compared to sound enamel, fluorotic lesions have a relatively well-mineralized outer surface layer, beneath which diffuse porosities are present in the subsurface zone due to hypomineralization.[15] As WSLs have both mineral and organic content, light is deflected multiple times at their interface. This results in scattering of light in multiple directions and very little to no light reaches the dentin. As a result, the dentin imparts no color to the area, and the lesions appear white clinically. The scattering coefficient of light is the number of times a photon changes direction per millimeter length of its path.[16] This scattering coefficient increases by a power of three in the case of demineralization.[17] The refractive index of hydroxyapatite present in the enamel is 1.62, whereas that of water/organic content/ethanol is 1.33, and that of air is 1.4.[18]

Due to this, all the light is scattered in the well-defined WSL, whereas in diffuse WSLs with no definite borders and less demineralization, some wavelengths of light reach the dentin, giving some color.[19]

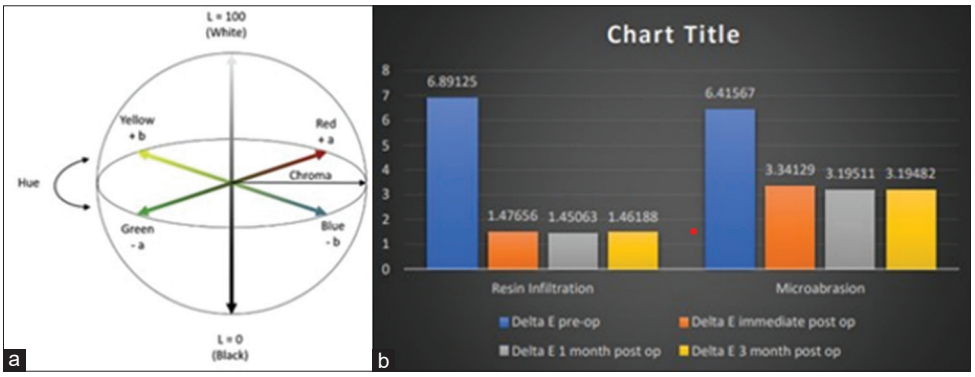
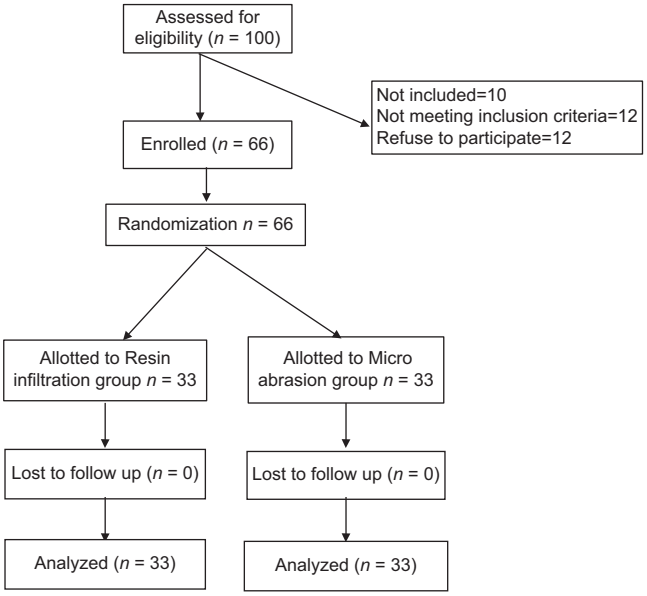


Figure 1: (a) CIELAB color space diagram. (b) DE value of both groups at different time

Figure 2: (a-d) Microabrasion group – preoperative, immediate postoperative 1- and 3-month follow-up and, (e-h) Resin infiltration group – preoperative, immediate postoperative 1- and 3-month follow-up



Flow chart 1: Randomized clinical trial flow chart

In the present study, L* values (i.e. decrease in whiteness) of WSL decreased significantly in both the groups. However, the decrease in the L* value was more in the resin infiltration group than the microabrasion group. There were no significant changes in the a* value in both the groups. The b* value increased in both groups; however, the change was not statistically significant. This suggests that enamel translucency increased, and it reflected the color of underlying dentin.

DE values of SAE and WSL were significantly lower in resin infiltration group immediately postoperatively with a mean value of 1.47 [Table 1] which suggested that it was within clinically acceptable range as compared to microabrasion group which was 3.34 [Table 2].

According to the latest guidance on color measurements published by the International Organization for Standardization, color stability should be assessed based on 50:50% acceptability (AT: $\Delta E^*ab = 2.7$ and $\Delta E_{00} = 1.8$) and 50:50% perceptibility (PT: $\Delta E^*ab = 1.2$ and $\Delta E_{00} = 0.8$) thresholds. In this sense, if the total color difference

Table 1: Intragroup comparison of delta E between pre- and postoperative in resin infiltration group

	n	Mean±SD	Mean difference	*P*
Pair 1				
DE preoperative	33	6.891±3.37	5.41	<0.001*
DE immediate postoperative	33	1.48±0.34		
Pair 2				
DE preoperative	33	6.89±3.37	5.44	<0.001*
DE 1 month postoperative	33	1.45±0.35		
Pair 3				
DE preoperative	33	6.89±3.37	5.43	<0.001*
DE 3 months postoperative	33	1.16±0.37		

*Statistically significant value. SD: Standard deviation, DE: Delta E

Table 2: Intragroup comparison of delta E difference between pre- and postoperative in microabrasion group

	n	Mean±SD	Mean difference	*P*
Pair 1				
DE preoperative	33	6.42±2.87	3.07	<0.001*
DE immediate postoperative	33	3.34±2.45		
Pair 2				
DE preoperative	33	6.42±2.87	3.22	<0.001*
DE 1 month postoperative	33	3.2±2.48		
Pair 3				
DE preoperative	33	6.42±2.87	3.22	<0.001*
DE 3 month postoperative	33	3.19±2.48		

*Statistically significant value. SD: Standard deviation, DE: Delta E

measured before and after treatment is at or below PT, it represents an excellent match; if the difference is between PT and AT, it represents an acceptable match; and if the difference is above AT, it represents an unacceptable match.[20]

Yetkiner *et al*. did a study, in which they compared resin infiltration, microabrasion, and fluoride application on artificially created WSLs. They concluded infiltration and microabrasion treatment significantly reduced L* value as compared to fluoride application, thereby reducing the whitish appearance of the teeth, whereas the a* value and b* value increased significantly in both the groups.[21]

Some WSLs could not achieve optimal results even after treatment. This could be attributed to the depth of the WSL, which may not be restricted to the superficial part of the enamel. It is reported that 200 μm of superficial enamel is removed by microabrasion, whereas resin infiltration occurs up to 60 μm. WSLs greater than these may not show favorable outcome with either of the treatment modalities.[22] Therefore, case selection should be cautiously done.

DE values of SAE and WSL were significantly constant in both groups over the period of 3 months, which suggested that results were stable (Ib).

Cazzolla *et al*. also showed sufficient durability of resin infiltration technique with clinically stable esthetic results in the treatment of postorthodontic WSLs.[23] Paris and Meyer-Lueckel reported the first successful immediate improvement of the esthetic appearance of WSLs that remained stable until the 10th month of follow-up.[24] Shivanna *et al*.[11] and Basaran *et al*.[25] reported the successful immediate masking of postorthodontic lesions in teeth treated with the resin infiltration technique. Shivann *et al*. reported result stability at the end of a 3-month review period.

CONCLUSIONS

Both techniques reduced the whiteness of the WSLs, but resin infiltration is a more efficient technique in immediately eliminating the WSL as compared to microabrasion. The result obtained was stable for 3 months in both groups. Further long-term study needs to be conducted for assessing the long-term treatment outcome.

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Conflicts of interest
There are no conflicts of interest.

REFERENCES

1. Davis NC. Smile design. Dent Clin North Am 2007;51:299-318, vii.
2. Moskowitz ME, Nayyar A. Determinants of dental esthetics: A rational for smile analysis and treatment. Compend Contin Educ Dent 1995;16:1164, 1166.
3. Abanto Alvarez J, Rezende KM, Marocho SM, Alves FB, Celiberti P, Ciamponi AL. Dental fluorosis: Exposure, prevention and management. Med Oral Patol Oral Cir Bucal 2009;14:E103-7.
4. Sagarika N, Suchindran S, Loganathan S, Gopikrishna V. Prevalence of white spot lesion in a section of Indian population undergoing fixed orthodontic treatment: An *in vivo* assessment using the visual international caries detection and assessment system II criteria. J Conserv Dent 2012;15:104-8.
5. Robinson C, Brookes SJ, Kirkham J, Wood SR, Shore RC. *In vitro* studies of the penetration of adhesive resins into artificial caries-like lesions. Caries Res 2001;35:136-41.
6. Croll TP, Bullock GA. Enamel microabrasion for removal of smooth surface decalcification lesions. J Clin Orthod 1994;28:365-70.
7. Mathias J, Kavitha S, Mahalaxmi S. A comparison of surface roughness after micro abrasion of enamel with and without using CPP-ACP: An *in vitro* study. J Conserv Dent 2009;12:22-5.
8. Bhandari R, Thakur S, Singhal P, Chauhan D, Jayam C, Jain T. Concealment effect of resin infiltration on incisor of grade I molar incisor hypomineralization patients: An *in vivo* study. J Conserv Dent 2018;21:450-4.
9. Meyer-Lueckel H, Paris S. Improved resin infiltration of natural caries lesions. J Dent Res 2008;87:1112-6.
10. Subramaniam P, Girish Babu KL, Lakhotia D. Evaluation of penetration depth of a commercially available resin infiltrate into artificially created enamel lesions: An *in vitro* study. J Conserv Dent 2014;17:146-9.
11. Shivanna V, Shivakumar B. Novel treatment of white spot lesions: A report of two cases. J Conserv Dent 2011;14:423-6.
12. Tirlet G, Chabouis HF, Attal JP. Infiltration, a new therapy for masking enamel white spots: A 19-month follow-up case series. Eur J Esthet Dent 2013;8:180-90.
13. Greenwall L. White lesion eradication using resin infiltration. Int Dent Afr Ed 2013;3:54-62.
14. Todorova VI, Filipov IA, Khaliq AF, Verma P. Aesthetic improvement of white spot fluorosis lesions with resin infiltration. Folia Med (Plovdiv) 2020;62:208-13.
15. Yanagisawa T, Takuma S, Fejerskov O. Ultrastructure and composition of enamel in human dental fluorosis. Adv Dent Res 1989;3:203-10.
16. Ogaard B, Ten Bosch JJ. Regression of white spot enamel lesions. A new optical method for quantitative longitudinal evaluation *in vivo*. Am J Orthod Dentofacial Orthop 1994;106:238-42.
17. Ko CC, Tantbirojn D, Wang T, Douglas WH. Optical scattering power for characterization of mineral loss. J Dent Res 2000;79:1584-9.
18. Prasada KL, Penta PK, Ramya KM. Spectrophotometric evaluation of white spot lesion treatment using novel resin infiltration material (ICON(®)). J Conserv Dent 2018;21:531-5.
19. Rocha Gomes Torres C, Borges AB, Torres LM, Gomes IS, de Oliveira RS. Effect of caries infiltration technique and fluoride therapy on the colour masking of white spot lesions. J Dent 2011;39:202-7.
20. Della Bona A, Pecho OE, Ghinea R, Cardona JC, Paravina RD, Perez MM. Influence of bleaching and aging procedures on color and whiteness of dental composites. Oper Dent 2019;44:648-58.
21. Yetkiner E, Wegehaupt F, Wiegand A, Attin R, Attin T. Colour improvement and stability of white spot lesions following infiltration, micro-abrasion, or fluoride treatments *in vitro*. Eur J Orthod 2014;36:595-602.
22. Davila JM, Buonocore MG, Greeley CB, Provenza DV. Adhesive penetration in human artificial and natural white spots. J Dent Res 1975;54:999-1008.
23. Cazzolla AP, De Franco AR, Lacaita M, Lacarbonara V. Efficacy of 4-year treatment of icon infiltration resin on postorthodontic white spot lesions. BMJ Case Rep 2018;2018:r-225639.
24. Paris S, Meyer-Lueckel H. Masking of labial enamel white spot lesions by resin infiltration: A clinical report. Quintessence Int 2009;40:713-8.
25. Basaran G, Veli, Ilknur, & Goncu Basaran. Non-cavitated Approach for the Treatment of White Spot Lesions: A Case Report: International Dental Research. 2017;1:65-69.