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Colour of White Spot Lesions after Non-Invasive Treatment Modalities: An in-vitro study

Yasmine S Hedayet[1], Omaima H Ghallab[2], Mohammed N M Anwar[3]

Abstract

Introduction: this study evaluated the effect of different non-invasive treatment modalities on white spot lesions affecting enamel on the change in enamel color. These treatments included using a non-fluoride toothpaste, fluoride toothpaste, Icon resin infiltration, non-fluoride toothpaste followed by icon, fluoride toothpaste followed by icon.

Aim of the study: The study was conducted to evaluate the change in color of white spot lesions of human premolar teeth after application of different non-invasive treatment modalities.

Methodology: 35 human sound premolar teeth were collected, they were randomly assigned into 5 groups each contained 7 samples. Group1: Non-fluoride toothpaste (NF) applied to WSLs twice a day for 30 days, Group2: Non-fluoride toothpaste applied to WSLs twice a day for 30 days followed by resin infiltration (NF/I), Group3: Fluoride Toothpaste applied on WSL for 30 days (F), Group4: Fluoride toothpaste applied for 30 days followed by resin infiltration (F/I), Group5: Resin infiltration applied for once. Enamel shade of each tooth was measured using the Vita Easyshade device before formation of white spot lesion, after white spot lesions and after application of different treatments.

Results: The lowest ΔE calculated belonged to (I) group meaning that the resin infiltration was the treatment giving the lowest difference in enamel shade before and after treatment. There was no statistical significance between the ΔE of (NF/I) group and the (I) group. Both groups gave clinically accepted results. The highest ΔE belonged to (NF) group. There was no statistical significance between the (F) and the (F/I) groups, also both showed clinically unaccepted results. Group 5 (I) also showed the lowest statistical ΔL* value of the treated surface.

Conclusions: Resin infiltration (ICON) has a determinant effect on improvement of artificially induced white spot lesions. Resin infiltration outcome is affected by fluoride application.

KEY WORDS: white spot lesions, resin infiltration, enamel color

1. B.D.S. Ain Shams University
2. Professor of Operative Dentistry, Faculty of Dentistry. Ain Shams University.
3. Lecturer of Operative Dentistry, Faculty of dentistry. Ain Shams University.

Introduction:

The early stage of carious lesions is observed as white spot lesions, these are subsurface enamel demineralization with intact surface which is due to the higher concentration of calcium at the surface(1).

The activity of the white spot lesion affects the way it appears in the oral cavity ,controlling the disease would lead to change of the lesion from being rough and chalky (the clinical picture of an active lesion) to being bright and smooth (clinical picture of inactive lesion)(2).

White spot lesions represent aesthetic problem in case they took place in anterior teeth as in case of more than 25% of patients receiving orthodontic treatment who develop at least one new lesion during treatment duration.(1) It can also arise from developmental cause such as fluorosis or simply as an early caries lesion due to lack of oral hygiene measures(3).

Modern dentistry is aiming to focus on conservative, non-invasive treatment instead of invasive treatment strategies of carious lesions. Among the different non-invasive treatments used to treat, white lesions are the application of re-mineralization products such as fluorides, casein phosphopeptide-amorphous calcium phosphate [CPP-ACP] or resin-based products, such as resin infiltration(4).

Re-mineralization of WSLs is considered a reasonable and conservative way of intervention, three methods of white spot lesions treatment have been selected, and those are treatment with a fluoride containing toothpaste, non-fluoride toothpaste and resin infiltration in addition to the combination of fluoride toothpaste with resin infiltration at a time and the combination of non-fluoride toothpaste with resin infiltration another time.

The use of a toothpaste containing fluoride is considered the most conservative way of re-mineralization being done by the patient at home, for toothpaste to have a significant effect its fluoride content should be 1000 ppt or more(5). The action of toothpaste containing fluoride takes place by elevating the level of fluoride in the oral cavity(6).

Another treatment option is infiltration. Infiltration is a recent way of treatment which uses a low viscosity resin to infiltrate the porous enamel found in WSLs. Hydrochloric acid etching is first used to increase the permeability of the outer most layer of enamel allowing triethyleneglycol dimethacrylate-based resin to penetrate into the deeper layers. This resin is said to have the same refractive index as that of sound enamel therefore not only does it increases the strength of weakened enamel prisms but also it enhances the appearance of the lesion aesthetically(7).

A fluoridated and non-fluoridated toothpastes were used to find out if the fluoride had hindering effect on the action of resin infiltration.

The aim of the study is to evaluate the change in color of white spot lesions after application of different treatment modalities;

1. Non-fluoridated toothpaste (NF).

2. Non-fluoridated toothpaste followed by Resin infiltration (NF/I).
3. Fluoridated toothpaste (F).
4. Fluoridated toothpaste followed by Resin infiltration (F/I).
5. Resin infiltration (I).

The null hypothesis: There is no difference among the treatment modalities regarding the color of white spot lesions.

Material and methods

1- Materials:

Fluoride toothpaste used was **Sensodyne Flouride** Eva cosmetics corp. egypt **GlaxoSmithKline.** The non- Flouride toothpaste was **Sensodyne original** Eva cosmetics corp. Egypt **GlaxoSmithKline.**

Resin infiltration material was **ICON** DMG Hamburg, Germany.

2- Methods:

Sample size calculation was performed using G*Power (version 3.1.9.2 2) to set power =95%.(8) The predicted sample size (n) was 7 samples per group. An additional sample was prepared to be studied under polarized light microscope after creation of white spot lesion and after treatment application.

3- Samples grouping:

The teeth with induced white spot lesions were assigned randomly into 5 groups each containing 7 teeth, groups are divided according to re-mineralization techniques follows:

- Non-fluoridated toothpaste (NF) applied on WSLs twice a day for 30 days.(9)
- Non-fluoridated toothpaste applied on WSLs twice a day for 30 days followed by Resin infiltration (NF/I).
- Fluoride Toothpaste (F) applied on WSLs twice a day for 30 days.
- Fluoride Toothpaste applied on WSLs twice a day for 30 days followed by Resin infiltration (F/I).
- Resin infiltration applied for once.

4- Sample preparation:

The middle-middle third of the premolars buccal surface was chosen to be the area exposed to the demineralizing solution therefore adhesive tape cut into circles with 5 mm diameter were made to be put on the buccal surface of each tooth ,then nail polish was applied to cover all over the tooth. The sticker circle was then removed leaving the only area that was going to be exposed to the demineralized solution.

5- Formation of white spot lesions:

White spot lesions formed by immersing the collected samples in acidic buffer solution (pH 4.4, for 5 days) (10). The demineralizing solution was refreshed each second day to keep the pH constant.

Figure 1: photograph showing the contents of resin infiltration kit.

6- Treatment application:

Each remineralizing agent was applied to the induced WSL according to the manufacturer's instructions.

or the resin infiltration group (n=7), the resin infiltrant (Icon, DMG, Hamburg, Germany) was applied according to the manufacturer's instructions: 15% HCl (Icon Etch, DMG, Hamburg, Germany) was directly applied from the syringe and left for 2 minutes, then rinsed off with water for 30 seconds. The WSLs were desiccated for 10 seconds using air-water spray, followed by the application of 99% ethanol (Icon Dry, DMG, Hamburg, Germany), and air-dried for 10 seconds. Resin infiltrant (Icon Infiltrant, DMG, Hamburg, Germany) was applied to the WSLs with the sponge applicator provided with the kit, and left for 3 minutes, then light-cured for 40 seconds using LED light curing unit (Elipar S10, 3M ESPE, USA) with an intensity of 1200 mW/cm^2. Then, a second coat of Infiltrant was applied and left for 1 minute, then lightcured for 40 seconds.

As for the toothpaste groups the samples were washed every day twice using an automated toothbrush (Oral-B PRO 500 electric rechargeable toothbrush). For optimum standardization for the used pressure, load fixation device was used where the toothbrush was hanged freely above each sample under its own weight and a 200g load (1.96 N).

7- Measuring the change in color:

Change in color is measured in all samples three times

1. Before the formation of whit spot lesion (baseline)
2. After formation of white spot lesions (demineralized enamel surface).
3. After treatment (re-mineralized enamel surface).

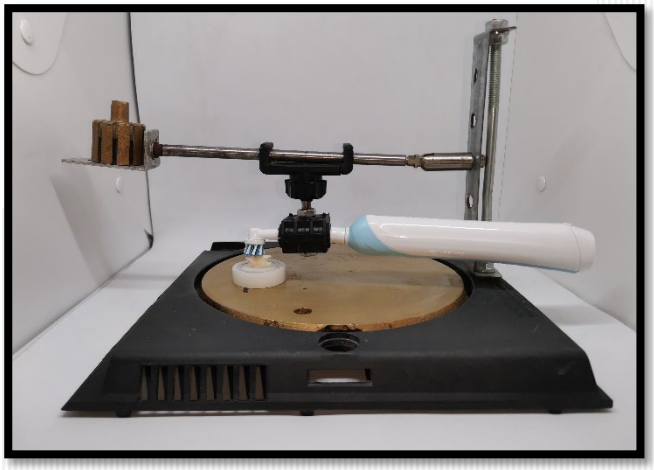

Figure 2: photograph showing the load fixation device with the electric toothbrush fixed to it.

Figure 3: photograph showing the Vita Easyshade device.

The three parameters were measured for each sample before white spot lesion creation (baseline), after white spot lesion formation (demineralized enamel surface) and then after treatment application (re-mineralized enamel surface). The calculated ΔE value was between the baseline measurement and the remineralized enamel surface measurement.

A ΔE value between 1 and 3.7 was found to be visible to the human eye but still clinically acceptable.(11).

8- **Statistical analysis:**

All data were collected tabulated and subjected to statistical analysis. IBM® SPSS® version 21.0. (Amonk, IBM Corp., NY) was used for statistical analysis. Descriptive statistics were computed with mean and standard deviation and one-way analysis of variance. Post hoc analysis with the Tukey's honest significant difference test was used to compare the data between the groups. Statistical significance was set at $P < 0.05$.

Measurements were made using spectrophotometer VITA Easyshade® Advance 4.0.

Results:

a. Descriptive analysis:

According to the collected data from the one-way ANOVA test for the color difference between the baseline color measurement and the re-mineralized enamel surface color measurement of samples, the non-fluoride toothpaste group (NF) gave the highest mean value which was not clinically accepted, while the resin infiltration group (I) gave the lowest mean value which was clinically accepted. The fluoride toothpaste group (F) and the fluoride toothpaste followed by resin infiltration group (F/I) had mean values of (4.91 and 4.22 respectively); those values were also not clinically accepted. The closest mean value to that of the resin infiltration group (I), was the mean value of the non-fluoride toothpaste followed by resin infiltration group (NF/I) (3.48) and it was also clinically accepted.

b. Statistical analysis:

i.The effect of different treatment strategies on color change (ΔE):

One-way ANOVA test showed that the surface treatment of demineralized enamel surface has statistical significant effect on ΔE.

The (NF) group showed the highest statistical ΔE value of the treated surface with a significant statistical difference between it and the rest of the treatment groups.

On the other hand, the (I) and the (NF/I) groups showed the lowest statistical ΔE values of the treated surface and there is a significant statistical difference between it and the rest of the treatment groups.

ii.The effect of different treatment strategies on change in lightness of enamel color (ΔL):

One-way ANOVA test showed that the surface treatment of demineralized enamel surface has statistical significant effect on (ΔL).

The (I) and the (NF/I) groups showed the lowest statistical (ΔL) value of the treated surface, in addition to being the only statistically significant group compared to the rest of the treatment groups which had no significant statistical difference.

Discussion:

The aim of this study was to evaluate the effect of ICON resin infiltration on the color of enamel white spot lesions comparing its effect with two types of toothpastes alone and combined with ICON.

Toothpaste is most likely to be the best choice for administering fluoride. Toothpastes can contain fluoride in various chemical forms mainly as sodium fluoride (NaF), sodium mono fluoro-phosphate (Na_2 FPO_3), amine fluoride (C_{27} H_{60} F_2 N_2 O_3), stannous fluoride (SnF_2) or combinations of these (12).

A Fluoridated and non-fluoridated toothpastes were used to evaluate the effect of different pretreatments on the outcome of resin infiltration and to find out if the fluoride had a hindering effect on the action of resin infiltration.(13)

Results of the present study revealed a significant effect of surface treatment on the color improvement of white spot lesions. Color change values for resin infiltration were the lowest among the other treatment groups. There was no statistical significance between the resin infiltration group and the non-fluoride and resin infiltration group. The result indicates that resin infiltration had the highest effectiveness among the other treatments in masking the WSLs and restoring the original color of enamel. This may be because the air or water in the micro-porosities of WSLs was replaced with resin, leading to less light scattering within the enamel as well as the ability of the low viscosity resin to completely infiltrate the white spot lesions by capillary action therefore blocking the diffusion pathways.

These results conflicted with results of ΔE calculated by **Yuan et al., 2014** (14)**,** the ΔE value between baseline measurement and following application of resin infiltration was (2.9±1.2). The difference in ΔE values between the present study and that study may be attributed to the fact that the ΔE value was calculated as a mean value for a follow up duration of 6 weeks after treatment application. In addition to using a different spectrophotometer which was the CrystalEye Olympus. The two spectrophotometers depend on different concepts for measuring tooth color.(15).

The value of ΔE also conflicted with the value calculated by **Prasada, Penta and Ramya (2018),** which was ΔE of 3.4 ± 0.3 after resin infiltration which is also clinically acceptable, this value was calculated two month after treatment application where the samples were stored in a solution of artificial saliva till the time of color measurement. In the present study color measurement took place directly after treatment application hence the lower value of ΔE. (16).

A measurement for ΔL was made as the L^* index indicates lightness and the human eye sees and perceives this color parameter more clearly because the quality of rods responsible for black and white vision is much higher than that of cones responsible for color vision, meaning that the human eye is more sensitive to L* color parameter more than a* and b* color parameters.(17).

Conclusions:

Under the limitations of this study, it can be concluded that:

1. Resin infiltration (ICON) has a determinant effect on improvement of artificially induced white spot lesions.
2. Resin infiltration outcome is affected by fluoride application.

There was no conflict of interests.

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