

Treatment of White Spot Lesions: Comparative Evaluation of Three Minimally Invasive Treatment Protocols: Re-Mineralization with CPP-ACP, Micro-Abrasion in Combination with Vital Bleaching and Resin Infiltration: An In Vivo Study

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ABSTRACT

Background: White spot lesions mark the beginning of the carious lesion. They can be seen as chalky white discoloration on the surface of the teeth. This discoloration can cause altered aesthetics and is hence a concern for the patients. The three commonly used treatment modalities for the masking of these lesions is remineralization with CPP-ACP paste, micro-abrasion followed with bleaching and resin infiltration. The aim of this study was to evaluate and compare the efficacy of less-invasive techniques (remineralization by CPP-ACP Paste, Micro-abrasion with bleaching and Resin infiltration) in masking the white spot lesions on teeth. The patients that showed white patchy discolorations on labial surfaces of upper and lower anterior teeth. Pre-Operative photographs for each patient were recorded. The patients were then asked to score their photos on a scale of 0 to 10 on the Heft-Parker Verbal Analog Scale. The difference between the scoring pre and post the treatment was then calculated and recorded as the change in the discoloration after the respective treatment protocol. The change in the discoloration of the teeth was evaluated to see the potential of the treatment modalities selected for masking the white spot lesions on the teeth. From the observation it can be evaluated that the change in the white spot lesions was least in the patients from group I i.e. remineralization using CPP-ACP. The aesthetic improvement in patients of group II who were subjected to micro-abrasion and bleaching was better if compared with that of group I but were not as satisfying as that seen in group III. The patients in group III who were subjected to resin infiltration technique showed maximum improvement in the aesthetics post the treatment. Thus, it was proved that the maximum change in white spot lesions was seen in group III and least was observed in Group I. The present study proved resin infiltration to be most effective in masking the white spot lesions on teeth when compared with remineralization with CPP-ACP and microabrasion with bleaching.

Keywords: aesthetics, carious lesion, demineralization.

INTRODUCTION

White spot lesions can be clinically defined as opaque, white areas caused by the loss of minerals

below the outermost enamel layer. (1) These lesions are caused due to the imbalance between demineralization and remineralization resulting from an acidic environment created by cariogenic

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bacteria. (2) These lesions are a result of accumulation of plaque and bacteria caused due to poor oral hygiene. (3)

They are the first clinical sign of enamel caries and so it is extremely important to diagnose and manage them at an early stage. (4) Although these lesions can appear on any tooth surfaces, facial surfaces of the anterior teeth are most frequently affected and thus cause aesthetic problems. Several studies on WSLs show a high rate of prevalence of the disease. These rates are as high as 50% to 96%. (5) The conventional treatment approach of white spot lesions is based on restoration, which, in most instances can be very invasive. (6)

Attempts have been made towards conservation of tooth structure by using high concentrations of topical fluoride, but since these solutions do not eliminate its whitish opaque aspect, aesthetics remain compromised. (7) Clinical studies too confirmed its lack in cosmetic improvement or considerable reduction of the carious lesions according to International Caries Detection and Assessment System. (8) Extrinsic staining may cause a brownish discoloration of arrested lesions, which are aesthetically even more challenging and persist for years. (9) In deeper lesions, due to the formations of hypermineralized layer the remineralization of the subsurface lesion body is hampered. (10) Hence long-term aesthetics remain questionable. Besides treatment needs to be commenced early and performed regularly. Therefore, success of the treatment depends on the patient's compliance. (11) (12)

Routine use of casein phosphopeptide- amorphous calcium phosphate (CPP-ACP) has been suggested to prevent WSL. (13) If salivary or plaque calcium, phosphate or fluoride ions are present in adequate amounts, they can also promote remineralization of previously demineralized enamel. (14) A number of different mediums have been introduced to deliver the CPP-ACP, including a water-based mousse, a topical cream, chewing gum, mouth rinses, and sugar-free lozenges. A newer product GC Tooth Mousse Plus (GC India), containing 900ppm fluoride and casein phosphopeptide amorphous calcium phosphate, has been developed.

Microabrasion treatment is based on the principles described by Croll. (15) Microabrasion has been

used often to reduce the contrast between white spot lesions and the surrounding tooth surface to make it uniform to the tooth color. (16) Microabrasion can be used in combination with in-office bleaching, resulting in a better aesthetic outcome. (17) Studies have demonstrated satisfactory results with microabrasion in the opinion of both dentist and patients. (18)

An alternative approach for superficial sealing might be to arrest carious lesions by infiltration of the pores within the enamel caries with light curing resins creating a diffusion barrier within the lesion without establishing any material on enamel surface. (19) Caries infiltration technique was introduced to allow penetration of low viscosity resin into the porous lesion body of enamel caries. (20) (21) Thereby diffusing the pathways for cariogenic acids are blocked and lesions are sealed inside and not on their surface. (22) In addition to its action in the control of caries progression, the resin infiltration of white spot lesion produces a positive effect in masking the color of teeth, because the lesions trend to lose their whitish appearance, looking similar to sound enamel. (23)

As all the three treatment modalities have been suggested to improve the aesthetic appearance of white spot lesion, when investigated individually, a need to compare their effectiveness has given rise to the current investigation.

The aim of this study was to evaluate and compare the efficacy of less-invasive techniques (remineralization by CPP-ACP Paste, Micro-abrasion with bleaching and Resin infiltration) in masking the white spot lesions on teeth.

Approval for this in Vivo study was obtained from the institutional ethics committee of Bharati Vidyapeeth Deemed to be university Dental College and Hospital, Navi Mumbai. The patients reporting to the OPD of Department of Conservative Dentistry and Endodontics were checked and patients who displayed white spot lesions were invited to participate in the study. Thirty such patients were selected for the study. ICDAS II system (International Caries Detection and Assessment System) was used to score the white spot lesions. The patients selected were from age group of 14yrs to 60 years, female and male. The patients that

showed white patchy discolorations on labial surfaces of upper and lower anterior teeth. A



Fig 1: Pre-Operative Photograph.



Fig 2: Casts and Vacuum Trays.



Fig 3: Remineralization Paste Application



Fig 4: Post-Operative Photograph.



Fig 5: Pre-Operative Photograph.



Fig 6: Micro-Abrasion with abrasive paste.



Fig 7: In-Office Bleaching.



Fig 8: Post-Operative Photograph Photos for Group III.

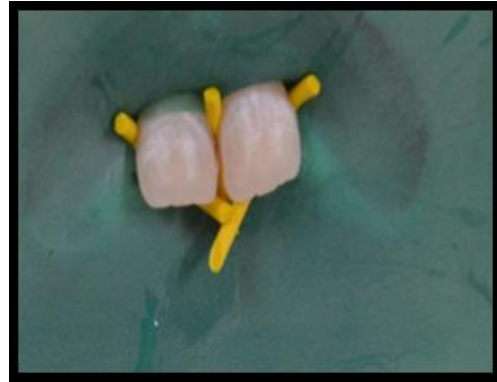


Fig 12: Post desiccation photograph.



Fig 9: Pre-Operative Photograph.



Fig 13: Resin Infiltration,



Fig 10: HCl Acid Application.

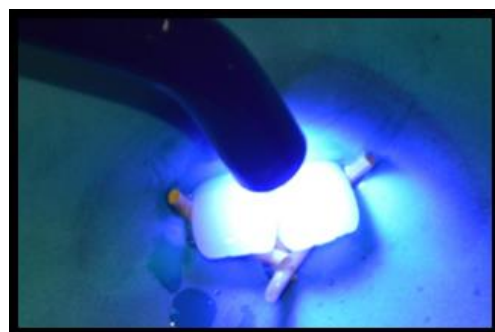


Fig 14: Curing of the Resin Infiltrant.

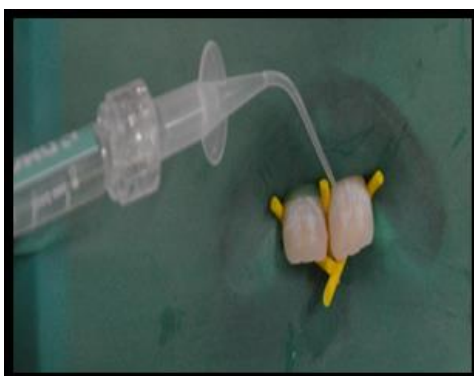


Fig 11: Desiccation using 99% Ethanol.

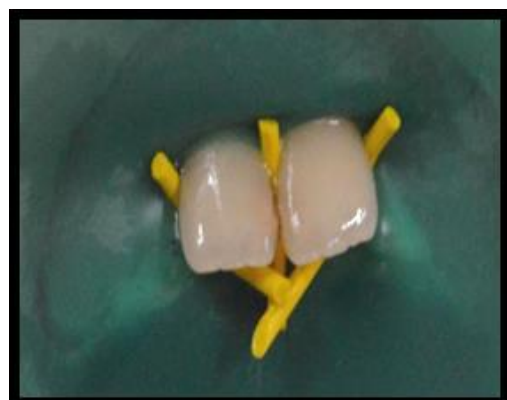


Fig 15: Post-Operative Photograph.

patient information sheet and a consent form for the patient were given to the patient to be well oriented with the procedures. All the patients were given meticulous oral hygiene instruction to be sure that the patient is able to perform correct tooth brushing and flossing. The study groups were divided in three groups on the basis of the treatment modalities selected to treat white spot lesions i.e. Group 1 i.e. Remineralization with CPP-ACP Paste (GC Plus Mousse, GC India), Group 2 i.e., Microabrasion using 37% phosphoric acid (Ivoclar) and pumice along with bleaching (Pola office Bleaching) and Group 3 i.e. caries infiltration with resin infiltrate (Resin Infiltration, ICON) where each consisted of ten patients.

Evaluation

Pre-Operative and Postoperative photographs for each patient were recorded. Photographs were taken digitally with a Nikon D3200 DSLR camera equipped with an 18 mm to 110 mm micro lens. The photographs were cropped to include 6 maxillary anterior teeth i.e. 13, 12, 11, 21, 22, 23. The images were saved in a 3000 × 1200-pixel format with Microsoft Photo manager. (Microsoft Office). The patients were then asked to score their photos on a scale of 0 to 10 on the Heft-Parker Verbal Analog Scale. The patients were explained about the scoring system, where the severity of the discoloration was rated from 0 to 10 in an ascending manner. The difference between the scoring pre and post the treatment was then calculated and recorded as the change in the discoloration after the respective treatment protocol.

MATERIALS AND METHODS

Group I: - Remineralization with CPP-ACP

Once the patient had scored the lesions, an upper and lower arch impression was recorded with rubber base material (Aquasil Dentsply) and a working cast was poured (Figure 1). The working cast was then used to obtain a vacuum tray using the 0.75 mm PET-G sheet (Scheu Duran, SCHEU) and pressure moulding device (Biostar, SCHEU) (Figure 2). The vacuum trays were tried in the patient's mouth and if required minor

adjustments were made. The patient was given instruction about usage of the remineralizing paste (GC Tooth Mousse Plus; GC India). The patient was instructed to coat the inner surface of the tray with a uniform thin layer of the remineralizing paste and then to wear the tray for 3 minutes (Figure 3). The patient was asked to repeat this procedure twice a day for a course of 15 days and then to report back to the clinic. (Figure 4) Out of 10 a total of 7 patients reported back after completing the remineralization protocol for 15 days (Form 2). The patients were then again asked to score the discoloration on the Heft-Parker Verbal Analog Scale. The difference in the scorings was recorded as the change in the discoloration post remineralization protocol for treating white spot lesions.

Group II: - Micro Abrasion and Vital Bleaching.

Once the patient had scored the lesions, the patients were subjected to micro abrasion (Figure 6). A paste of thick consistency from equal volumes of pumice and 37% phosphoric acid (Ivoclar) was made. A thick layer of 2 to 3 mm was applied on the affected surfaces of the teeth and then the teeth were micro abraded with polishing brush and rubber cup with slight pressure for 60 to 120 seconds. The tooth was hydrated at proper intervals to avoid over drying and confirm removal of white spot lesions. This procedure was continued till 3 to 4 minutes whenever required. The patient was treated with in-office vital teeth bleaching with Pola Office (Figure 7). Post treatment photographs were taken and the patient was asked to score the discoloration post treatment (Figure 8). The difference in the score was recorded as the change in the discoloration after treatment. The patient was prescribed with a prophylactic desensitizing tooth paste (Colgate Sensitive Pro-Relief, Colgate).

Group III: - Resin Infiltration

For the purpose of infiltration each tooth was isolated under rubber dam to ensure a dry working field. The teeth were etched with 15% hydrochloric acid (Icon-Etch, supplies with the ICON kit and composed of 15% hydrochloric acid, water, silica and additives; DMG) for 120 seconds to expose the layer of the lesion body. Subsequently the etching gel was washed away thoroughly for 30 seconds using a water spray and dried. The lesions were then desiccated with 99% ethanol (ICON Dry; DMG)

for 30 seconds followed by air drying. An infiltrate resin (ICON Infiltrate; DMG) was applied to the surface and allowed to penetrate inside for 3 minutes. Excessive material was wiped away with a cotton pellet from the surface before curing for 40 seconds. Post treatment photographs were taken and the patient was asked to score the discoloration post treatment. The difference in the score was recorded as the change in the discoloration after treatment.

Statistics

Data of patients with satisfaction was expressed as numbers with percentages. Change in VAS scores after treatment was calculated and expressed as mean change with S.E.M. Since this is the first study of its kind, the sample size was not based on any assumptions and statistical estimations. It was planned to have 10 samples per study group. Total 30 samples were selected and randomly allotted to the respective study groups. Data was tested for normality using Anderson-Darling test.

As the data was tested normal one-way analysis of variance (ANOVA) was applied for comparison of different groups. This was followed by post-hoc Dunnett's multiple group comparison for individual comparisons. Null hypothesis (H_0): There were no differences between the three study groups for the change in VAS scores. Alternate hypothesis (H_1): At least two of the three study groups are different in terms of the change in VAS scores. All testing was done using two-sided tests at alpha 0.05. Thus, the criteria for rejecting the null hypothesis was decided to be a 'p' value of <0.05.

RESULTS

The change in the discoloration of the teeth was evaluated to see the potential of the treatment modalities selected for masking the white spot lesions on the teeth. This change was calculated from the scores of VAS obtained from the patient's pre and post treatment. Post-hoc Scheffe's test was not performed because $p=0.569$, i.e. there are no significant differences between the three groups with respect to the VAS scores.

The mean (SD) change in the VAS scores of white spot lesions for group I was 1.1429 (0.37), group II was 3.1000 (0.87) and group III was 5.3000 (1.05).

The 'p' value was less than 0.05 suggesting that the difference in the score was statistically significant. Thus Scheffé test was performed for all pair wise comparisons. This showed there was statically significant difference between groups 2 and 3, groups 1 and 3 and the groups 1 and 2.

Table 1: The difference in the pre and post VAS scores of white spot lesions.

Sr. No	(Group I) Remineralization with CPP-ACP	(Group II) Micro Abrasion with Bleaching	(Group III) Resin Infiltration
1	1	3	5
2	1	2	6
3	1	4	5
4	1	3	5
5	1	4	6
6	2	2	5
7	1	2	3
8	-	3	5
9	-	4	6
10	-	4	7

Table 2 :- The mean of the difference in the pre and post VAS scores of White spot lesions.

Group	Mean	SD
Group I (Remineralization with CPP-ACP)	1.14	0.37
Group II (Micro Abrasion and Bleaching)	3.10	0.87
Group III (Resin Infiltration)	5.30	1.05

From the observation it can be evaluated that the change in the white spot lesions was least in the patients from group I i.e. remineralization using CPP-ACP. The aesthetic improvement in patients of group II who were subjected to micro-abrasion and bleaching was better if compared with that of group I but were not as satisfying as that seen in group III. The patients in group III who were subjected to resin infiltration technique showed maximum improvement in the aesthetics post the treatment. Thus, it was proved that the maximum change in

white spot lesions was seen in group III and least was observed in Group I

The Null hypothesis (H_0), that there are no differences between the three study groups for the change in VAS scores was rejected.

DISCUSSION

An established white spot lesion has a chalky, opaque appearance, as light is scattered mainly within the lesion body. (24) The effect of scattering in a heterogeneous system such as enamel prisms surrounded by fluid medium is a function of difference in refractive indices of two involved components. The RI of enamel is approximately 1.65, since the RI of water is 1.33 and of air is 1.00 the larger difference and consequently a greater scattering are produced at the enamel/air interface. (25) The appearance of white spot lesions is related to its activity, and the consequence of disease control would be seen clinically by a change from chalky and rough to bright and smooth surface. The study was performed to determine which treatment method is most efficient in masking these white spot lesions on the teeth.

The first treatment group in this study was remineralization using CPP-ACP paste. It has been shown in previous studies that casein phosphopeptides have the ability to stabilize calcium phosphate in solution by forming colloidal casein phosphopeptide-amorphous phosphate complexes (CPP-ACP). This prevents the calcium phosphate growth to the critical size required for nucleation and subsequent precipitation of minerals. (26) (27) (28) CPP-ACP has been demonstrated to have anticariogenic potential. In this study CPP-ACP paste used had an additional benefit of containing fluoride. (29) The remineralizing paste used in the study was GC Tooth Mousse Plus (GC India), Plus by GC India which contains CPP-ACP along with 900ppm of fluoride.

Tooth Mousse showed a higher remineralizing potential when applied as a topical coating after the use of fluoridated toothpaste. (30) In the present study remineralizing paste was delivered in the vacuum trays which made it possible to keep it in contact with the tooth surface for complete 3 minutes. But this technique also involved an

additional step of making a customized vacuum tray for each patient.

From the total of 10 patients who were assigned to this treatment modality only 7 patients returned back after completing the remineralization protocol. Only 70% patients reported back for the post treatment VAS records. This is the first study of its kind; the sample size was not based on any assumptions and statistical estimations. Thus, as for the number of samples, anything more than 6 samples was acceptable for statistical analysis. So, the drop out of 30% of patients from the study did not have any effects on the statistical analysis of the results. Although, this did not cause any alterations in the results obtained from this study because we have calculated the mean of all the data recorded from the patients, this could be counted as one of limitations of this treatment method.

This study showed that the change in the appearance of white spot lesions was least when the patients were subjected to remineralization therapy using CPP-ACP in comparison to the patients subjected to microabrasion with bleaching or resin infiltration. The change though noticeable was not satisfying to the patients. More investigative studies are required to study the effect of the remineralizing pastes on the aesthetic improvement of the WSLs. Though this study did not show comparable improvements with CPP-ACP it could not be denied that it did have a certain effect on the WSLs.

In the present study it was noticed that the aesthetic improvement seen with microabrasion was better than that of remineralization using CPP-ACP, but the results were not as good as the results seen with resin infiltration. This could be attributed to the depth of action of both the techniques. In cases of remineralization the paste acted only on the surface level by increasing the mineral contents on the surface of the teeth. However, in the cases of microabrasion and bleaching enamel microabrasion abrades the enamel surface leaving a highly polished surface which can then be bleached. (29) Research indicates that one minute application of the abrasive paste removes 12 μ m of the tooth surface layer on the first application and 26 μ m on subsequent applications. (31) In this way a portion of the whitened enamel is removed and is the

camouflaged by the highly polished enamel surface. Research has demonstrated that although microabrasion removes small amounts of enamel surface, the newly polished surface is less susceptible to bacterial colonization and demineralization than the natural non-abraded enamel. (32)

When the aesthetic improvement seen in all the three groups was compared, it was evidently clear that resin infiltration technique had the maximum effect on the white spot lesions. With an initially demineralized caries lesion, the tiny porous openings and widened intercrystalline spaces act as diffusion pathways for acids and dissolved minerals. Based on these insights, it is possible to infiltrate incipient lesions with low viscosity resins. Thus, instead of removing the porous carious tissue at a relatively late stage in the disease process, successful attempts to fill the micro porosities of lesions at a much earlier stage of lesion development have been suggested in previous studies. (33) The infiltration technique allows reducing of micro porosities and is capable of strengthening the demineralized tissue by mechanical support. The micro hardness of WSLs is increased significantly with the resin infiltration technique. (4)

The infiltrate used in this study was Triethylene glycol-dimethacrylate (TEGDMA), a light curable resin that are optimized for rapid penetration into the capillary structures of the lesion body. These resins exhibit a very low viscosity, low contact angles to the enamel and high surface tension. These properties are important for complete depth of penetration of the resin infiltrate into the body of the enamel lesions. (34) The principle of masking enamel lesions by resin infiltration is based on changes in light scattering within the lesion. This novel technique involves infiltration of the carious lesions with resin that has an RI (1.146) closest to that of healthy enamel. This is how the difference in RI between porosities and enamel is negligible and lesions appear similar to that of the surrounding sound enamel. It has a camouflaging effect and requires no shade matching. Lesions lose their whitish opaque color and blend reasonably well with the surrounding natural tooth structure. An immediate improvement in the aesthetic appearance is observed. (34) This immediate

improvement in the appearance of white spot lesions was also seen in the present study.

The present study proved resin infiltration to be most effective in masking the white spot lesions on teeth when compared with remineralization with CPP-ACP and microabrasion with bleaching.

Limitations and Future Scope

The patients in the study were asked to score the white spot lesions on the Heft Parker VAS scale. This methodology was partially adapted from a study by Greg J. Huang and his co-workers. (35) This could create a bias and thus the lesions should be scored by a panel of experienced dentists and a mean of all should be recorded as the final score.

SUMMARY AND CONCLUSION

The three methods tested for masking the WSLs on teeth proved to be effective at varying degrees. From the present study it can be concluded that resin infiltration is the most suitable method for masking of the white spot lesions of the teeth when compared with remineralization using CPP-ACP paste and micro-abrasion with bleaching. In the limitations of the present study, more research-oriented studies need to be done comparing different treatment modalities for masking white spot lesions on teeth.

CONFLICTS OF INTEREST

The authors declare they have no potential conflict of interests regarding this article.

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