Management of Post Orthodontic White Spot Lesions Using Resin Infiltration and CPP-ACP Materials- A Clinical Study

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Objectives: *The purpose of this present study was to assess and compare the effectiveness and durability of topical application of remineralizing agent Casein Phospho Peptide (CPP-ACP, Toothmousse, GC corporation, Germany, Europe) and Resin infiltration (ICON, DMG, Hamburg, Germany) in the management of post orthodontic white spot lesions. Study design: A Randomized Control clinical trial was conducted among 60 children who had undergone fixed orthodontic therapy presented with white spot lesions (WSLs) on maxillary or mandibular anteriors after debonding. Identification of WSLs was done with International Caries Detection and Assessment System (ICDAS II) criteria. The clinical photographs recorded were used to measure the size of lesion. The color assessment of the lesion and sound adjacent enamel was recorded by using spectrophotometer (Vita-Easy shade 4.0, VITA Zahnfabrik, Germany). Area of the lesion was calculated using Digimizer software (Digimizer, MedCalc Software, Belgium). The selected samples were randomly allocated into two groups: Group I- Resin infiltration- Icon, DMG, Germany, (n=30) and Group II- Casein Phosphopeptide-Amorphous Calcium Phosphate (CPP-ACP)–GC Toothmousse, GC Corporation, Germany, (n=30). The WSLs were evaluated immediately following resin infiltration, and in CPP-ACP group after 1 month. In both the groups lesions were evaluated at 1, 3, 6 and 12 months.* ***Results:*** *There was significant reduction in lesion area, and improvement in color of white spot lesions with both of the treatment modalities.* ***Conclusion:*** *Both the resin infiltration and CPP-ACP have desired and durable esthetic improvement in terms of reduction in the area as well as color of post orthodontic white spot lesions.*

Keywords: *White Spot Lesions (WSLs), Casein Phosphopeptide-Amorphous Calcium Phosphate CPP-ACP), International Caries Detection and Assessment System (ICDAS II)*

INTRODUCTION

Fixed orthodontic therapy is intended to correct various types of malocclusions in order to achieve a proper alignment of teeth in its arch for improvement of occlusal function and esthetics. Since the fixed orthodontic therapy requires a long term treatment period there is a need for stringent oral hygiene maintenance to prevent the plaque accumulation in and around the orthodontic components attached to the enamel surface. After the completion of treatment and debonding of brackets, the white demineralised area that appear on the tooth surface is termed as white spot lesion (WSL), which leads to unaesthetic appearance and increases the chance of initiation of dental caries.

White Spot Lesion (WSL) is sub-surface enamel porosity due to demineralisation, manifests clinically as a milky white opacity, located on smooth surfaces. The early stage of the lesion is amenable to remineralisation or arrest and if left untreated leads to further demineralization resulting in cavity formation on smooth enamel surfaces. The basic philosophy behind the management of these early lesions is focussed on promoting natural remineralization and preventing further demineralisation. This can be achieved through topical application of remineralization agents (CPP-ACP) and resin-based materials that improves esthetics as well.

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Application of fluoride may prevent initiation of dental caries in and around orthodontic brackets and further arrest incipient lesions. Complete repair of the lesion most likely is inhibited with the application of concentrated fluoride, as the initial higher amount of calcium fluoride formed transforms the surface area to fluorapatite. The visible white spot lesions on facial surface developed during orthodontic treatment should therefore not be treated topically with concentrated fluoride agents since it may prevent complete repair.[1-5] As the patients opting for treatment of WSL are mostly young children and adolescents, primary focus shall be laid down towards minimal invasive procedures which prevent excessive sacrifice of enamel tissue by use of remineralising paste or Resin Infiltration Technique.

MATERIALS AND METHOD

Trial design

This was a single-center, parallel-arm, randomised controlled trial performed with 60 children from both sexes (Male-25, Female-35) in the age range of 13-15 years who had undergone fixed orthodontic therapy for duration of 12-24 months with 1:1 allocation approved by the institutional ethical committee (IEC/SCBDCH/052/2019). The null hypothesis considered that there would be no difference in improvement of color and reduction in area of white spot lesion between the experimental and control groups observed over 12 months.

Sample size

Using the computer application G*POWER Version 3.1.9.7, the required sample size was determined with the given α=0.05, power = 0.85, and effect size =0.8 (assuming the large effect size difference between the groups), to be 30 subjects per group.

Participants were recruited from patients who underwent labial fixed orthodontic treatment with 0.022-inch slot McLaughlin, Bennett, and Trevisi (MBT) prescription brackets (Leone, U.S.A), bonded with light-cured composite resin adhesive (Transbond XT, 3M unitek, U.S.A) in the Department of Pediatric and Preventive Dentistry, S.C.B Dental College and Hospital, Cuttack, Odisha. The study period was from January 2018 to October 2019 with prior approval from Institutional Ethics Committee. S.C.B Dental College and Hospital, Cuttack

Informed consents were obtained from parents/caregivers of the children after explaining the details of the treatment procedure in a designated format in regional and English languages.

Inclusion Criteria

1. Children who had undergone fixed orthodontic appliance therapy.
2. Should have at least one white spot lesion on the labial surface of either maxillary or mandibular anterior teeth after debonding.
3. CPP-ACP group should give consent and carry out the use of the supplied material as a home use.

Randomization and Blinding

For this study, interventions were performed in participants using the random order generated in RANDOM.org software. The sequence was kept in sequential numbered opaque sealed envelopes and concealed from the principal investigator. Both the participants and investigator were blinded.

The investigator was trained and standardized by the principal investigator to calibrate different variables for the identification of WSLs using ICDAS II criteria (Code 1 or 2). The clinical photographs recorded were used to measure the size of the lesion using Digimizer software (Digimizer, MedCalc Software, Belgium). The color assessment (ΔE) of the lesion and sound adjacent enamel was recorded by using spectrophotometer (Vita-Easy shade 4.0, VITA Zahnfabrik, Germany). The selected samples were randomly allocated to two groups according to treatment received.

Group I- Resin infiltration -Icon, DMG, Germany, (n=30).

Group II- Casein Phosphopeptide-Amorphous Calcium phosphate (CPP-ACP)-GC Tooth mousse, GC corporation, Germany, Europe, (n=30).

Before the application of topical agents on white spot lesions, oral prophylaxis was carried out and the affected tooth to be treated was cleaned with a rubber cup with prophylaxis paste (3M, Clinpro, United States of America) in both the groups. The assessment of WSL was carried out using ICDAS II criteria (Code 1 or 2), Pre–treatment photograph of the lesion was obtained and shade Analysis of the lesion and sound adjacent enamel was recorded using Spectrophotometer (Vita-Easy shade 4.0, VITA Zahnfabrik, Germany). The area of White Spot Lesion was calculated using Image analyzing software (Digimizer, MedCalc Software, Belgium). The white spot lesions were evaluated immediately following the application of the resin infiltration, and in the CPP-ACP group after 1 month. In both the groups, lesions were evaluated at time intervals of 1, 3, 6 and 12 months.

The collected data were subjected to statistical analysis using SPSS version 22.0 (Armonk, NY, IBM Corp). Demographic variables were analyzed using proportions. Independent sample 't' test was used to compare the mean difference in color (ΔE) and lesion area (A, mm^2) between the study groups at various time intervals. Repeated Measures ANOVA was used to determine the mean difference in ΔE and A, within study groups at various time intervals.

RESULTS

In the resin infiltration group, 25 cases (92.60%) belonged to ICDAS code 1 and 2 cases with (7.40%) code 2. In the CPP-ACP group, 25 cases (86.21%) belonged to code 1 and 4 cases with (13.79%) code 2. A statistically significant decrease in ΔE was observed immediately after resin infiltration and stable at follow up visits at 1, 3, 6 and 12 months. Lesion area showed statistically significant reduction immediately after resin infiltration and at 1, 3, 6 and 12 months.

In the CPP-ACP group, statistically significant decrease in ΔE was observed at 1 month and subsequent improvement at 3, 6 and 12 months follow up. Lesion area showed statistically significant reduction at 1and 3 months follow up and remained stable at 6 and 12 months.

Table 1: Comparison of study groups for the difference in color (ΔE) between white spot lesion and sound adjacent enamel at various time intervals

Time intervals	Group I (Mean ± SD)	Group II (Mean ± SD)	Mean difference	*p* value
T_0	5.68 ± 1.72	5.67 ± 1.76	0.009	0.984
T_1	3.9 ± 0.44	5.5 ± 1.76	1.6	0.001*
T_2	3.6 ± 0.22	4.6 ± 1.6	0.938	0.005*
T_3	3.6 ± 0.21	3.9 ± 0.6	0.284	0.03*
T_4	3.6 ± 0.23	3.8 ± 0.59	0.253	0.04*
T_5	3.6 ± 0.23	3.8 ± 0.59	0.253	0.04*

T_0-before intervention, T_1-immediately after intervention, T_2-1 month, T_3-3 months, T_4- 6 months, T_5- 12 months.

*- Statistically significant.

Table 2: Comparison of the difference in lesion area (A, mm²) between study groups at various time intervals

Time intervals	Group I (Mean ± SD)	Group II (Mean ±SD)	Mean difference	*p* value
T_0	15.65 ± 12.6	11.76 ± 6.8	3.891	0.155
T_1	4.78 ± 3.8	10.7 ± 6.8	6.983	0.001*
T_2	3.18 ± 3	6.1 ± 6	2.968	0.03*
T_3	2.34 ± 2	3.2 ± 3.1	0.9544	0.207
T_4	2.2 ± 2	2.7 ± 2	0.531	0.366
T_5	2.17 ± 2	2.6 ± 2.1	0.43	0.348

*- Statistically significant

DISCUSSION

The prime objective of fixed orthodontic therapy in young children and adolescents is to achieve a pleasing and beautiful smile by a proper, harmonious alignment of anterior teeth and establishment of functional occlusion. An undesirable but common complication is formation of white chalky decalcified areas under and around the brackets which is termed as white spot lesions (WSLs) with prevalence ranges from 2-96 percent. The severity of demineralization hinders the enamel translucency leading to unaesthetic appearance and the menace for the occurrence of dental caries. The fixed orthodontic appliance attached to the tooth surfaces results in new retention sites and has shown an increase in proliferation of Streptococci mutans and Lactobacilli.[2, 6-23]

ICDAS II criteria were selected since other methods have difficulties in interpreting, validating and complexity of scoring, which have both content and co relational validity with the added advantage of easiness in identification.

The photographic image method for *in-vivo* measurements of post-orthodontic enamel lesions was selected because it seems to be the simplest and relevant approach for quantification of lesion size and color. Image processing software can analyse the photograph, thereby quantifying the area of the lesion. In addition to the assessment of lesion size, it can retrieve the exact position of white spot lesion in future follow-up visits.

The various methods that are currently advocated ranges from visual subjective comparisons using colour porcelain or acrylic shade guides to instrumental objective measurements using spectrophotometers, colorimeters, and image analysis techniques. Spectrophotometric method (Vita-Easy shade 4.0, VITA Zahnfabrik, Germany) was used to assess tooth color because objective and quantitative color assessment can be done. Color can be quantified using Commission de l'Eclairage (CIELab*) system and difference between two colors can be calculated using a spectrophotometer that gives ΔE value. A difference of 3.7 units is considered a clinical indicator for mismatching colors or color change. White spot lesions are clinically invisible when the ΔE unit between the sound enamel and white spot lesions is <3.7.[24-28]

The philosophy behind the management of post orthodontic white spot lesions based on three important treatment methods. 1) **Natural remineralization-** can be achieved with topical fluoride supplements and maintenance with good oral hygiene practice throughout the course of treatment which can reduce or eliminate the occurrence of white spot lesions. 2) **Microabrasion** with application of 18% Hydrochloric acid (HCl) and polishing with pumice powder leads to an improvement in esthetics primarily results from the physical removal of discoloured enamel. The microabrasion technique causes surface abrasion and has been commonly used for the treatment of WSLs can remove up to 250 micrometers of enamel and a quite invasive procedure with loss of tooth structure. 3) **Remineralization technique** -The milk protein casein can be digested with trypsin and complexed with calcium and inorganic phosphate ions to produce Casein Phosphopeptide- stabilized Amorphous Calcium Phosphate nano-complexes also known as Recaldent. CPP-ACP stabilize the calcium and phosphate ions preventing transformation into crystalline phases and maintain a highly supersaturated solution. CPP stabilized calcium phosphate solutions can remineralize enamel subsurface lesions at a rate of $1.5\text{-}3.9\times10^{-8}$ mol hydroxyapatite/ m^2 /s.

Hinging on the modern philosophy of minimal invasive dentistry; this infiltration technique has been increasingly gaining popularity in the recent past with application of resin infiltration technique, a minimally invasive treatment with low viscous light-curing resin (Tetra Ethylene Glycol Di Meth Acrylate- TEGDMA) that has a high penetration coefficient used for treatment of subsurface lesions. In artificial lesions, brief etching with 37% phosphoric acid-enhanced resin penetration, but with thicker and more mineralized surface layers in natural lesions, it was assumed that this etching procedure would not be effective in eroding the surface layer. The latter study confirmed that etching with 15% hydrochloric acid gel leads to more effective erosion of surface layer (40 micrometer) compared with 37% phosphoric acid gel. The resin infiltration technique in ameliorating WSLs in terms of color and area has been reported in literature, that when micropores of WSLs were infiltrated by resin (Refractive Index-1.46) which is approximated to that of enamel (1.65), the difference in refractive indices between porosities and enamel was decreased to an invisible level. Infiltrating white spot lesions have achieved highly esthetic results, not just immediately after treatment but for long term effect and durability. The assimilation of effects achieved was durable after 12 months.

The effect of CPP-ACP in regression of white spot lesions in terms of area, color and durability have been reported in literature that the application of CPP-ACP for 3 months followed by use of fluoride dentifrice for the next 3 months helps in regression of post orthodontic WSLs. The application of 10% CPP-ACP along with

normal oral hygiene procedures using fluoridated dentifrice (1000 ppm) for 3 months has significantly ameliorated post orthodontic white spot lesions. Significant regression of white spot lesions was observed after 3 months and scores achieved were stable over 1-year period.

In the present study, the distribution of WSLs was 96.3% in the maxillary arch and 3.70% in the mandibular arch. Most common teeth affected with WSL were maxillary incisors followed by mandibular canines, mandibular incisors, and maxillary canines. The results are comparable to the findings in earlier studies.[31]This can be attributed to a broad bracket base used in the maxillary arch, less salivary cleansing, and higher chance of plaque accumulation.[29-31]

Since the white spot lesions could become a potential side effect of conventional fixed orthodontic treatment, clinicians need alternative materials with the properties of potential remineralization effect and needs further research in this regards to prevent the undesired consequences.

CONCLUSION

1. Both the Resin infiltration and CPP-ACP have desired and durable esthetic improvement in the management of post orthodontic white spot lesions (WSLs).
2. Both the materials used have ameliorated post orthodontic white spot lesions in terms of reduction in the area of WSLs.
3. Both materials are recommended for the management of post orthodontic WSLs if proper protocol is maintained.

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