Clinical Evaluation of Enamel Demineralization during Orthodontic Treatment: An *in vivo* Study using GC Tooth Mousse Plus

**ABSTRACT**

**Aims and objectives:** Fixed orthodontic treatment makes oral hygiene procedures difficult and may result in enamel demineralization. Casein phosphopeptide-amorphous calcium phosphate (CPP-ACP) with fluorides (GC Tooth Mousse Plus) reduces the incidence of enamel demineralization. The objective of this study was to evaluate the effects of GC Tooth Mousse Plus application, on enamel demineralization in patients undergoing orthodontic treatment.

**Methodology:** Thirty subjects seeking orthodontic treatment were selected from patients visiting Department of Orthodontics in AB Shetty Memorial Institute of Dental Sciences, Mangalore. The subjects were divided into test and control group, and scanning electron microscopic (SEM) evaluation was done to compare level of surface roughness on samples of both the groups.

**Results:** No white spot lesion was clinically appreciable in either test or control group. After extracting the teeth, SEM images of surface of the teeth was graded and statistically evaluated with Pearson's Chi-square and likelihood ratio test. The results were significant with p-value below 0.001 which indicated increased surface roughness in controls compared to the test group patients.

**Conclusion:** Use of CCP-ACP with fluorides (GCTM+) as an adjunctive to thorough oral hygiene measures has proven to be effective in reducing enamel demineralization significantly.

**Keywords:** Enamel demineralization, White spot lesions, CPP-ACP, GC tooth mousse plus.


**Source of support:** Nil

**Conflict of interest:** None

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**Received on:** 7/9/13
**Accepted after Revision:** 21/9/13

**INTRODUCTION**

With rising awareness of facial esthetics, there has been an increase in the number of patients seeking orthodontic treatment. However, fixed orthodontic treatment makes oral hygiene procedures difficult for the patient and may result in enamel demineralization and periodontal problems.1 Enamel demineralization resulting in white spot lesions is a common occurrence around orthodontic attachments, owing to the formation of plaque retentive factors such as brackets, bands, modules, springs, etc.1 Nearly 50% of orthodontic patient exhibit clinically visible white spot lesion during orthodontic treatment that last approximately 2 years with smooth surface lesion increasing up to 50% in prevalence during treatment. These lesions are unesthetic, unhealthy and potentially irreversible.2 Labiogingival areas of the maxillary incisors and mandibular molars are commonly affected sites following orthodontic treatment. Visual detection of smooth surface enamel loss can be assessed by ICDAS criteria.3 Incipient lesions of enamel demineralization are not distinctly visible. However, drying the enamel surface for 5 seconds can demonstrate the loss of normal translucency of the enamel.4 Incorporation of fluorides in products like toothpastes, oral rinses, varnishes, luting cements (GIC and Resin cements) for orthodontic attachments have been used to inhibit the enamel demineralization around the orthodontic attachments. However, the fluoride released from these products lasts for first 48 hours, after which there is minimal or no fluoride released.5-8 Therefore, fluoride-containing products may not offer much needed long-term protection against enamel demineralization during orthodontic treatment.

Casein phosphopeptide-amorphous calcium phosphate (CPP-ACP) commercially available as GC Tooth Mousse has been used to reduce or eliminate the incidence of enamel demineralization. ‘GC Tooth Mousse’ is water based, sugar free cream containing the active ingredient CPP-ACP, when applied to tooth binds with biofilms, plaque, bacteria,
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hydroxyapatite and surrounding soft tissue localizing the bioavailable calcium and phosphate. The flavored Tooth Mousse stimulates the flow of saliva which enhances the effectiveness of CPP-ACP. *In vitro* and *in vivo* studies have confirmed the effectiveness of the product to decrease the incidence of enamel demineralization. The same has been suggested to decrease the incidence of enamel demineralization in patients undergoing fixed orthodontic treatment.

Purpose of the study—fluorides and CPP-ACP used individually are known to effectively inhibit enamel demineralization, but CPP-ACP with fluorides has been available and its efficacy against enamel demineralization in patients undergoing fixed orthodontic treatment needs to be evaluated.

**AIMS AND OBJECTIVES**

To compare the level of demineralization on:
- Teeth with orthodontic attachments and GC Tooth Mousse Plus.
- Teeth without orthodontic attachments and GC Tooth Mousse Plus.
- Teeth with orthodontic attachments and no GC Tooth Mousse Plus.

**MATERIALS AND METHODS**

**Source of Data**

Thirty subjects who gave their consent were selected from the patients visiting Department of Orthodontics in AB Shetty Memorial Institute of Dental Sciences, Mangalore. The subjects were divided into two groups:
- **Group A**: Test group representing 15 orthodontic patients using GC Tooth Mousse Plus as a preventive measure along with regular oral hygiene measures against enamel demineralization.
- **Group B**: Control group representing 15 orthodontic patients using only regular oral hygiene methods and no GC Tooth Mousse Plus as a supplement against enamel demineralization.

**Inclusion and Exclusion Criteria**

Patient requiring fixed orthodontic treatments as well as extraction of premolars for the therapeutic purpose were included. Patients with enamel hypoplasia, hypocalcification, fluorosis or even filled buccal surfaces were not included.

**Methodology**

Patients undergoing orthodontic treatment were educated about oral hygiene measures and the problems that may arise due to poor oral health during orthodontic treatment. During the bonding of orthodontic appliance in Group A patients the teeth indicated for extraction were bonded only on right arch (A-1), the teeth indicated for extraction on left arch were not bonded (A-2). Material used for application, i.e. the material under study, was GC Tooth Mousse Plus containing CPP-ACP and fluorides (Fig. 1). Professional application of GC Tooth Mousse Plus was done immediately after orthodontic appliance strap up in Group A subjects and were subsequently instructed to apply the same paste daily once at night after brushing their teeth for a period of 6 months. They were explained about the method of application. Group B subjects are educated on regular oral hygiene measures but are not supplemented with GC Tooth Mousse Plus or any compliance chart. Both groups were recalled on a monthly basis and visually examined for the incidence of new white spot lesions. The oral hygiene instructions were reinforced during each appointment.

At the end of 3 months, the teeth indicated for orthodontic extraction were extracted. About 10 samples randomly selected from each group, i.e. A-1, A-2 and B, are evaluated under scanning electron microscope (SEM). Scanning electron microscopic evaluation was to compare the level of demineralization in three conditions as follows:
- **Group A-1**: Teeth with bracket and from patients of test group.
- **Group A-2**: Teeth without bracket and from patients of test group.
- **Group B**: Teeth with brackets and from patients of control group.

All the extracted teeth were cleaned with formalin and distilled water thoroughly. The buccal cusps of all the teeth were cut off using a cutting disk (Fig. 2). These samples were sent for SEM evaluation at Indian Institute of Sciences at Bengaluru. Surface images for 10 samples of the entire three groups were scanned at ×1000.
RESULTS

The mean scoring of Groups A-1 was 1.8, Group A-2 was 1.3 and Group B was 3.6 and standard deviation was 0.74, 0.64, 0.91, of Group A-1, A-2 and B respectively. On evaluation with Pearson’s Chi-square and likelihood ratio test. The results were significant with p-value below 0.001, which indicated increased surface roughness in controls compared to the test group patients (Table 1). The scores were plotted on a graph (Graph 1).

DISCUSSION

Orthodontic treatment causes an increased risk of enamel demineralization by significant plaque accumulation around the bracket bases, most frequently on the cervical and middle thirds of the buccal surfaces of maxillary lateral incisors, mandibular canines and first premolars. Decalcification of the labial (buccal) surfaces of teeth during orthodontic therapy is a problem of clinical importance, 50% of the patients experienced an increase in white spots. Decreased access to the flow of saliva and the distance from bracket to free gingival margin is factors affects white spot formation. The area of white spots when quantitatively assessed was increased significantly during orthodontic treatment and decreased markedly during the first and second years post-treatment, but did not reach the pretreatment level even 12 years after debonding. White spot lesions classified as related to orthodontic appliance treatment showed similar results and might be a cariologic and cosmetic problem even 12 years after debonding. The use of topical

Method of Statistic Evaluation

All the images were scored by single examiner for three times at interval of 2 weeks between each scoring. Blinding of the examiner was done to avoid bias. The scoring was done as follows: All the SEM pictures were scored from 0 to 5, based on comparative surface roughness by a single examiner. Then, the scores were graded as follows:

• 0 and 1—mild roughness
• 2 and 3—moderate roughness
• 4 and 5—severe roughness

All the SEM pictures were scored from 0 to 5 based on comparative surface roughness by a single examiner (Figs 3 to 5). The readings were taken three times at an interval of 2 weeks between each scoring. This was done to eliminate intraexaminer bias. Blinding of the examiner was done to avoid bias. Pearson’s Chi-square and likelihood ratio test used for statistical analysis of SEM data.
Table 1: Chi-square tests for scores of surface roughness

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<th>Value</th>
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<th>Asymp. sig. (two-sided)</th>
<th>Exact sig. (two-sided)</th>
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<td>Pearson’s Chi-square</td>
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<td>Continuity correction</td>
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<td>Likelihood ratio</td>
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<td>Linear-by-linear association</td>
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<td>Number of valid cases</td>
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fluorides in addition to fluoride toothpaste appears to reduce the incidence of decalcification in patients undergoing orthodontic treatment with fixed appliances. Decreased incidence of decalcification is found in population with both fluoridated and nonfluoridated water supplies.15,16

Several preparations have been shown to reduce the incidence of decalcification in patients undergoing orthodontic treatment with fixed appliances, but none appears to be superior. It is not possible to recommend which topical preparations or schedules, provide the greatest decrease in decalcification.17 Glass ionomer cement as an orthodontic adhesive is more effective in preventing decalcification during fixed appliance treatment than a conventional composite resin but the evidence is weak and bonding with a glass ionomer adhesive is not recommended.18 Single topical application of fluoride varnish with a high concentration can decrease enamel lesion depth adjacent to bonded brackets for 3 months by about 40%.19

Combination of topical gel CPP-ACP applications, use of fluoride-releasing orthodontic materials may reduce the risk of enamel demineralization during orthodontic treatment. Enamel lesions remineralized with topical exposure to CPP-ACP have shown to be more resistant to subsequent acid challenge and capable to promote remineralization of enamel subsurface lesions with hydroxyapatite. The percentages of Ca in enamel were remarkably higher after 1 month from application of CPP-ACP. The effects of CPP-ACP have so far shown promising dose-related increases in enamel remineralization within already demineralized enamel lesion.

In this study, the effects of topical application of both CPP-ACP and fluorides in orthodontics patients were analyzed. Incidence of new white spots/enamel demineralization in patients undergoing orthodontic treatment. Level of demineralization was also assessed on the basis of surface roughness under SEM, and all the results were compared with control group.

Thirty orthodontic patients were divided into control and test subjects by lottery method to avoid selection bias. As this was an in vivo study, only the patients indicated for orthodontic extractions were selected. During the treatment course of 3 months, no new white spots appeared. Visual detection of the lesion is possible only after a substantial progress of the lesion. Until the demineralization has progressed to a certain level, initial sign of caries or demineralization, that is, the white spot lesion is not visible clinically. At this incipient stage of demineralization, the surface of the enamel which is undergoing spontaneous demineralization, and remineralization was evaluated at a higher magnification.20

Trimpeneers et al8 used intraoral photographic slides before and after mean treatment period of 21 months and white spot lesion were analyzed only after debonding the appliance. Gorelick L et al21 evaluated visually for mean intraoral exposure of 22 months and in few patients, least exposure intraorally was 12 months which is sufficient for white spots to develop. Mizrahi E also evaluated patients with completed orthodontic treatment, i.e. after mean exposure of 24 to 36 months. In the present study, the intraoral evaluation time was only 3 months, which may not be sufficient for the development of clinically appreciable white spot lesion. The effect of fluorides in reducing plaque accumulation, causing an alteration of adhesive properties between enamel and bacteria as well as between bacteria themselves, resulting in less plaque accumulation.21

In the present study, SEM revealed mild surface roughness even in teeth with no orthodontic attachment. When orthodontic attachment is present and teeth are supplemented with GC Tooth Mousse Plus, the teeth showed mild to moderate surface roughness, and in teeth which were bonded orthodontic attachment with no supplemented GC Tooth Mousse Plus application showed sever roughness in about 50% of the samples. This indicated that before the formation of white spot lesion the enamel demineralization is subclinically present and may aggregate to a clinically level leading to white spot lesion and further cavitations. Simultaneous application of CPP-ACP with additive fluorides and accompanied with thorough oral hygiene measure can prevent the inception of clinically visible white spots.

Artun J et al22 did a SEM evaluation of enamel surface changes after 3 years of orthodontic exposure, making a positive replica of the enamel surface. They also found enamel demineralization after debonding, which did not progress with removal of appliance. Sudjalim et al11 used quantitative light-induced fluorescence for evaluating enamel demineralization and proved added effects of CPP-ACP with
flurorides, and Bibilova et al. used flame atomic absorption spectrometry and found remarkably higher calcium after 1 month of GC Tooth Mouse application.

The prevention of enamel demineralization in orthodontic patients of this study could be related to the improved oral hygiene measures of the patients, with effects of flurorides and CPP-ACP causing increased resistance of enamel against demineralization and spontaneous remineralization of demineralizing lesion.

CONCLUSION
Casein phosphopeptide-amorphous calcium phosphate with flurorides (GCTM+) as an adjunctive to thorough oral hygiene measures has proven to be effective in reducing enamel demineralization significantly when compared to patients not using any such adjunctive.

FUTURE SCOPE OF THE STUDY
The oral hygiene also improves but this may be due to the active ingredient of the paste or just another motivation factor to the patient for maintaining better oral hygiene. Further placebo studies may be required to confirm it.

REFERENCES