Efficiency of remineralization agents on white spot lesions in teeth following debonding: A SEM study

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ABSTRACT

Aim and Objective: This study aimed to evaluate and compare enamel surface defects after debonding with the application of Curodont Repair and GC Tooth Mousse.

Materials and Methods: Twenty-one extracted premolar teeth were divided into five groups: normal natural teeth (n=1), Pre-control (PRC, n=5), Post-control (PTC, n=5), Curodont (CU, n=5), and GC mousse (GC, n=5). PRC samples were stored dry, while PTC samples were placed in artificial saliva for 90 days. CU and GC samples underwent daily applications of their respective agents for 90 days in artificial saliva. Scanning electron microscopy (SEM) and energy-dispersive X-ray spectroscopy (EDEX) were used to analyze enamel surfaces.

Results: SEM imaging showed a homogenous enamel surface in normal teeth. CU samples displayed smooth, coalesced enamel rods, while GC samples revealed interprismatic space filling with adherent granules, suggesting mineral deposition. EDEX analysis indicated significantly lower calcium and phosphorus levels in the PTC group, with the highest levels in the PRC group, followed by CU and GC groups. The results were statistically significant.

Conclusion: Both Curodont Repair and GC Tooth Mousse showed effective remineralization on enamel surfaces post-debonding, with Curodont Repair demonstrating superior performance. These results underscore the value of remineralization agents in managing enamel defects after orthodontic treatment.

KEYWORDS: Enamel demineralization, Orthodontic brackets debonding, GC mousse, Curodont Repair

INTRODUCTION

Fixed Orthodontic treatment for treatment of malocclusion provides a significant psychosocial benefit to patients, often improving self-esteem, contributing to one's overall quality of life.[1] Nonetheless, following the debonding of the orthodontic brackets, numerous changes occur on the tooth surface.[2]

Orthodontic treatment involves bonding, debonding, and clean- up procedures, resulting in structural defects. Loss of enamel by etching, White spot lesions, microcracks and scratches caused by the clean-up procedures are commonly encountered structural defects. Apart from these, there can be surface alteration due to decalcification caused by plaque accumulation around the orthodontic brackets during the orthodontic treatment.[3-7]

Few studies reported that the debonded enamel surface exhibited increased roughness compared to the enamel of control teeth, irrespective of the polishing bur used.[8,9] Various studies have reported a varying prevalence of surface roughness following debonding and enamel demineralization from 4.9% to 84% of tooth surfaces have raised concerns to the clinician.[11]

To prevent these white spot lesions and enamel demineralization, numerous preventive techniques have been undertaken by the use of fluoride varnish, APF gels, ACPP, self-assembling peptide, and Ozone therapy. The most effective being the ACPP and self-assembling peptide.[12] Hence the present study aims to evaluate and compare the enamel surface defects on teeth after debonding the bracket with application of remineralization agents (Curodont Repair and GC Tooth Mousse (Casein Phosphopeptide Amorphous Calcium Phosphate (CPP–ACP))).

MATERIALS AND METHODS

Study design, Study setting and Study population:

This in-vitro study was conducted on 21 natural human premolar teeth which have been therapeutically extracted from patients undergoing orthodontic treatment. The samples were divided into 5 groups: normal natural teeth (n=1, teeth with no lesions), Pre-control (PRC) group (n=5), Post-control (PTC) group (n=5), Curodont (CU) group (n=5), and GC mousse (GC) groups (n=5).

Selection criteria:

Inclusion Criteria: Therapeutically extracted premolar teeth without visible caries, cracks, restorations and hypoplasia.

Exclusion Criteria: Teeth with enamel cracks, caries, restorations, and hypoplastic teeth

Study procedure:

All the samples in Pre-control (PRC) group, Post-control (PTC) group, Curodont (CU) group, and GC mousse groups were etched with 37% orthophosphoric acid gel (3M) for 20 seconds followed by thorough washing and air drying for 20 seconds.

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The bonding agents were placed on the tooth and the brackets (pre-adjusted edgewise premolar brackets of 0.022" (3M, M.B.T prescription) that were bonded with the adhesive and light-cured for 20 seconds. Before light-curing the adhesive, the brackets were precisely placed on the tooth and excessive flash will be removed using a probe.

Precontrol (PRC) group debonded samples were preserved in dry medium. Postcontrol (PTC) group debonded samples were placed in artificial saliva for 90 days. In the Curodont (CU) group, the debonded samples, a single coat of Curodont Repair is applied every day and placed in artificial saliva for 90 days. Similarly, in GC mousse (GC) groups, debonded samples, a single coat of GC Tooth Mousse is applied every day and placed in artificial saliva for 90 days. The sample teeth were evaluated after 90 days.

To mimic the oral environment, the samples of each group underwent alterations in pH of artificial saliva medium (5, 5.5, 4.5) in daytime every 2 hours and 5.5 overnight. After 90 days the teeth specimens were evaluated for remineralization using SEM (scanning electron microscopy), and mineralization content was evaluated using EDEX.

In SEM, each sample was observed with increasing magnifications (500x, 1000x, 2000x, 4000x) to observe the enamel surface for areas of demineralization or remineralization. These photomicrographs were scored by Nucci et al., 2004 Scoring criteria;[15]

- Score 0: Enamel surface remained perfectly intact with no grooves, pits, and porosity
- Score 1: Presence of surface irregularities on enamel surface, without demineralization of prismatic and/or interprismatic enamel
- Score 2: Presence of wrinkles and demineralization of prismatic/interprismatic enamel
- Score 3: Diffuse demineralization involved the rod core, with decomposition of morphology of prism

RESULTS

The SEM imaging of normal teeth showed a homogenous enamel surface with fine cracks and fissures over the enamel surface. (Fig-1). SEM evaluation of Precontrol (PRC) group debonded samples revealed coarse scratches, wide grooves, and damage over the enamel surface with a noticeable clear surface boundary. (Fig-2) Whereas, Postcontrol (PTC) group debonded samples revealed circumferentially arranged enamel rods filled with inter rod material producing a typical keyhole appearance with fine cracks and fissures over the enamel surface with a noticeable clear surface boundary. Areas of isolated cavitations caused by erosion of the intact enamel surface showed deposition of bacterial colonies were also noted. (Fig 3)

SEM images of Curodont (CU) group shows smoothened and well coalesced enamel rods with enamel rods. (Fig-4). SEM images of GC mousse (GC) group shows filling of the interprismatic spaces with obvious formation of interprismatic substances seen as adherent granules or globules. These correspond to the redeposited minerals subsequent to mobilization of calcium and phosphate from the CCP-ACP. (Fig 5)

Postcontrol group had significantly lesser calcium and phosphorus percentage compared to other groups. Also, the highest calcium and phosphorus weight percentage was noted in precontrol group, followed by Curodont Repair and GC mousse groups. The results were statistically significant. (Table 1 and 2)

Table 1; Mean Calcium weight percentage among the groups

Groups	Mean calcium (wt%)	Independent t test P value
Normal natural teeth (n=1)	68.63	0.012*
Pre-control (PRC) group (n=5)	70.98	
Post-control (PTC) group (n=5)	64.67	
Curodont (CU) group (n=5)	69.99	
GC mousse (GC) group (n=5)	68.9	

Table 2; Mean phosphorus weight percentage among the groups

Groups	Mean phosphorus (wt%)	Independent t test P value
Normal natural teeth (n=1)	15.79	0.035*
Pre-control (PRC) group (n=5)	35.33	
Post-control (PTC) group (n=5)	29.02	
Curodont (CU) group (n=5)	34.16	
GC mousse (GC) group (n=5)	30.01	

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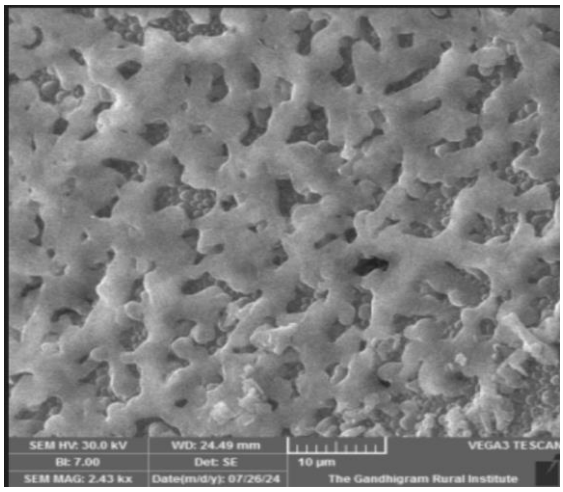

Figure 1; SEM images (*2000) of normal teeth specimens

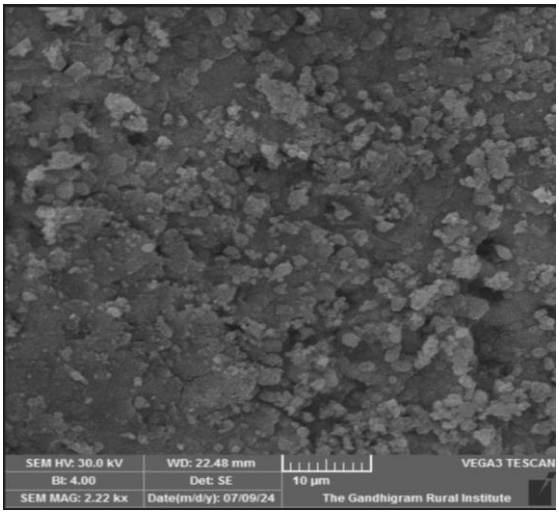

Figure 2; SEM images (*2000) of Precontrol (PRC) group debonded samples

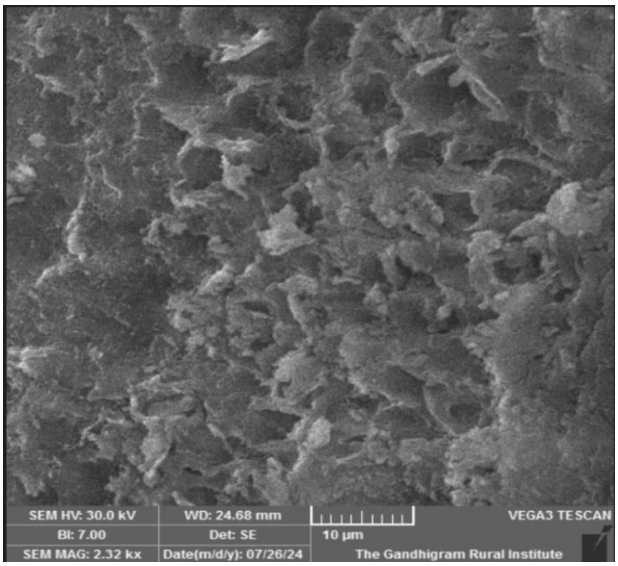

Figure 3; SEM images (*2000) of Postcontrol (PTC) group debonded samples

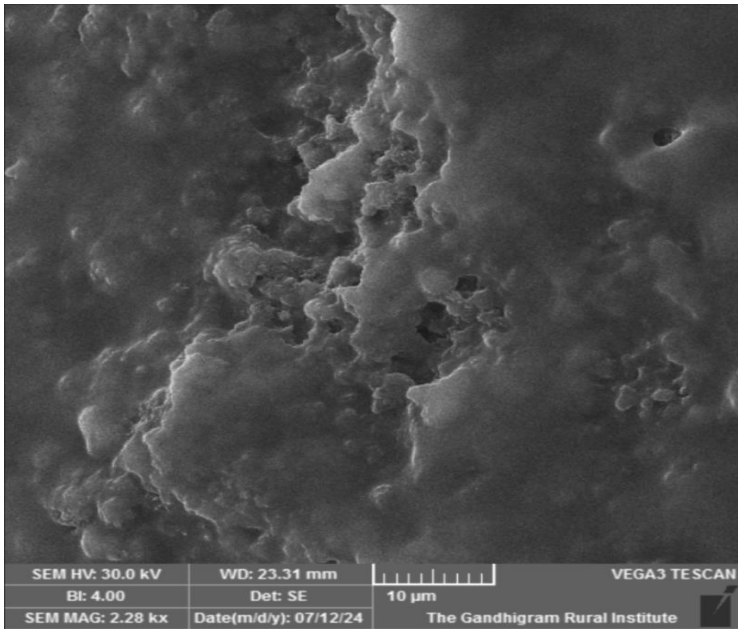

Figure 4; SEM images (*2000) of Curodont (CU) group debonded samples

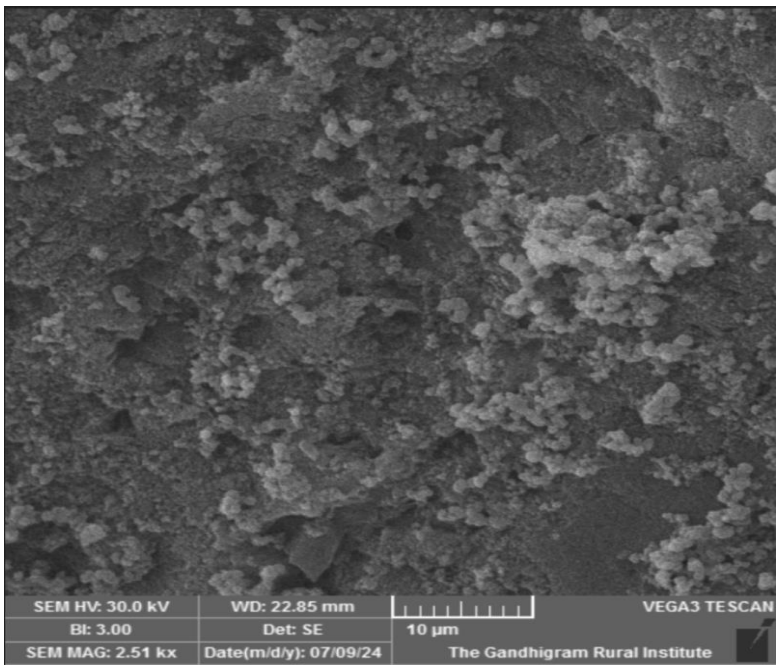

Figure 5; SEM images (*2000) of GC mousse (GC) group debonded samples

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DISCUSSION

Demineralization of enamel after orthodontic therapy frequently concerns the clinicians. Though the outermost layer of enamel is the hardest with higher fluoride contents, Gordon et al in their study reported that there was significantly more demineralization around the brackets.[16] This is due to the Irregularities that result from etching, and orthodontic brackets bonding intensifies the demineralization caused by plaque accumulation on tooth surfaces.

Almost 50% of patients exhibit clinically visible white spot lesions (WSL) in the orthodontic bracket placed area after debonding. However, these lesions gradually decrease in the first two years after debonding. Nonetheless, the demineralization regions will persist on the tooth surface even up to five years after debonding procedures.[17]

In the recent decade, several new materials that serve as remineralizing agents have been utilized to overcome these concerns. However, one of the commonest and oldest method in enamel remineralization is topical fluoride application to the surface of the enamel.[18-20]

There is insufficient literature regarding the surface enamel changes following debonding and application of commercially available fluoride based remineralizing agents like Curodont and GC mousse. Hence in the present study aimed to evaluate and compare the enamel surface defects on teeth after debonding the bracket with application of remineralization agents (Curodont Repair and GC Tooth Mousse).

Remineralisation is a process of providing calcium, phosphate, and fluoride ions from the oral environment to the tooth in order to convert ion deposition into crystals in demineralized enamel. In the present study, highest calcium and phosphorus weight percentage was noted in precontrol group, followed by Curodont Repair and GC mousse groups.

GC Tooth Mousse is a commercially available fluoride-based application. Casein Phosphopeptide Amorphous Calcium Phosphate (CPP–ACP), a milk product base, is the main component of GC Tooth Mousse. CPP–ACP is composed of two parts; Casein Phosphopeptide (CPP) and Amorphous Calcium Phosphate (ACP). CPP-ACFP prevents the activity of free calcium and phosphate ions, thus helping to keep enamel supersaturated, reducing demineralization and promoting remineralization. Free calcium and phosphate ions exit the CPP onto the enamel rod and form apatite crystals. Fluoride ions have an anticariogenic effect by helping to restore remineralization through the formation of fluorapatite on the enamel surface.[22,28] Thus the SEM images of GC mousse (GC) group in the present study shows filling of the interprismatic spaces with obvious formation of interprismatic substances seen as adherent granules or globules. These correspond to the redeposited minerals subsequent to mobilization of calcium and phosphate from the CCP-ACP

Curodont Repair is a biomimetic remineralizing agent that provides a therapeutic option for enamel regeneration.[21] It works by filling the intercrystalline spaces of enamel subsurface lesions through a self-

assembling peptide that builds a supramolecular three-dimensional, fibrous network in the acidic environment which attracts calcium phosphate from saliva and produced de novo hydroxyapatite crystals surrounding the matrix that contains fluoride which have synergistic effect and enhance faster remineralisation.[21] In the present study, the SEM images of Curodont (CU) group shows smoothened and well coalesced enamel rods with enamel rods. This can be attributed to the remineralising capability of Curodont Repair.

Amin et al in their study reported that Curodont Repair provided a better chance for complete healing of incipient lesions from ICDAS score 2 to score 0. The authors had compared Curodont Repair and GC Tooth Mousse and reported that Curodont was superior as a remineralizing agent by the reduction in the size of the white spot lesions.[21] In the present study, samples of Curodont CU and GC mousse groups showed signs of remineralization.

Bröseler et al [23,24] compared Curodont Repair to Duraphat and showed a significant difference in size of lesion for Curodont. The investigators added that the aqueous peptide P11-4 was beneficial in the treatment of early caries lesions. Overall, Curodont Repair provides a treatment option for enamel regeneration, providing a scaffold for improved remineralization of the lesion body.[25]

In a recent systematic review by Hu et al (2022) investigating the prevention of WSLs, acidulated phosphate fluoride (APF) foam showed the best remineralizing effectiveness in the long term (after debonding), followed by difluorosilane (Dfs) varnish and high-concentration fluoride toothpaste (HFT).[27] It is unclear whether remineralizing agents can effectively reverse WSLs based on the existing evidence.

The present study found that debonding of the orthodontic brackets caused scratches, grooves damaging the enamel surface. Also, the demineralization caused after debonding shows increased demineralization with cavities and microbial accumulation. However, the application of remineralizing agents like Curodont Repair and GC mousse had better effects in remineralisation of the defects and damages caused by debonding procedures.

The present study has quantitatively and qualitatively analyzed the enamel surface following debonding. To determine the remineralisation effect of these agents, it is best to investigate with both quantitative and qualitative methods. Hence, the results of the present study are reliable, but the small sample size should be considered. Amorphous Calcium Phosphate (CPP–ACP) is a milk product, hence it cannot be given to patients who have milk intolerance. CPP–ACP application as a remineralizing agent in vivo must be done with caution.

CONCLUSION

In conclusion from the results of the present study, both Curodont Repair and GC mousse have remineralizing capability on the tooth surface after debonding. The remineralising capability of Curodont Repair is better than GC mousse. The findings of the present study emphasize the necessity of application of the remineralising agents as the

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damage to the enamel surface following debonding may cause further complications like dental caries which require care and treatment.

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