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Original Article

Remineralizing potential of various agents on dental erosion

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ABSTRACT

Aim: The purpose of this study is to compare the effect of casein phosphopeptide-amorphous calcium phosphate (CPP-ACP, Tooth Mousse) containing and casein phosphopeptide-amorphous calcium phosphate with fluoride (CPP-ACPF, Tooth Mousse Plus) containing pastes on dental erosion.

Materials and methods: Thirty permanent non-carious premolars indicated for orthodontic extraction were included in this study and were sectioned in mesiodistal direction vertically. After immersion in the carbonated drink for 14 min, samples were treated with various remineralizing pastes which were CPP-ACP containing paste (Tooth Mousse) and CPP-ACPF containing paste (Tooth Mousse Plus) according to the manufacturer's instructions. Vickers Microhardness was recorded at baseline, after exposure to erosive drink and after treatment with remineralizing pastes. Data obtained was statistically analysed using Student t-test with a level of significance set at $p < 0.05$.

Results: CPP-ACP (Tooth Mousse) and CPP-ACP with fluoride (Tooth Mousse Plus) resulted in 30.52% and 38.98% increase in post-erosion microhardness values respectively. The remineralizing potential of CPP-ACP with fluoride containing paste (Tooth Mousse Plus) was significantly better than that of CPP-ACP containing paste (Tooth Mousse) ($p < 0.05$). **Conclusion:** Casein phosphopeptide-amorphous calcium phosphate with fluoride (CPP-ACPF, Tooth Mousse Plus) can be recommended to be used in preventing erosive tooth wear from acidic beverages.

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1. Introduction

Dental erosion is the area of localized loss of dental hard tissue chemically etched away from the tooth surface by acid dissolution without bacterial involvement.¹ Soft drink consumption has frequently been reported to be one of the most important risk factors of dental erosion.² As lifestyles have changed, there has been a 50% increase in consumption of soft drinks over the past few decades, especially among children and adolescents.³

It has been suggested that casein phosphopeptide-amorphous calcium phosphate (CPP-ACP) and casein phosphopeptide-amorphous calcium phosphate with fluoride (CPP-ACPF) have anti-erosive properties.⁴ When placed on the surface of tooth CPP-ACP interact with hydrogen ions and form calcium hydrogen phosphate which releases calcium and phosphate ions, thus aid in remineralization. While CPP-ACPF provide additional fluoride along with calcium and phosphate ions for remineralization.⁵

The current study was undertaken to compare the effect of casein phosphopeptide-amorphous calcium phosphate (CPP-ACP) containing and casein phosphopeptide-amorphous calcium phosphate with fluoride (CPP-ACPF) containing remineralizing pastes on dental erosion.

2. Subjects and methods

Sample size for the study undertaken was 30 permanent extracted premolars. Intact, non-carious, non-hypoplastic, not fractured and not malformed freshly human premolars extracted for orthodontic reasons were selected. Exclusion criteria was premolar teeth with both buccal and lingual surfaces carious, crown of the teeth fractured during extraction and hypoplastic or hypomineralised teeth. All selected teeth were used within three months of extraction as per recommended Occupational Safety & Health Administration (OSHA).

The teeth were cleaned using ultrasonic scaler. Crown was sectioned from the roots horizontally and then vertically in mesiodistal direction by means of slow speed diamond disk attached to the micromotor under water lubrication to produce two samples from each crown (Fig. 1). Therefore, total 60 samples were prepared out of 30 extracted premolars initially taken. The specimens were then embedded in self-cured acrylic resin. The buccal/lingual surfaces were wet ground using 400, 600, 1200, 2000 and 2500 grit silicon carbide paper to obtain a smooth flat surface. Baseline surface microhardness of sound enamel was measured on the buccal surface by means of a Vickers indenter with 100 g of force for 15 s. Four indentations per test were performed on each specimen during each experimental stage and the mean was taken.

All specimens were then immersed in carbonated drink for 14 min with in between washing with deionized water after every 2 min simulating in vivo soft drink consumption for one week (Fig. 2). After the erosion process was completed, all the specimens were rinsed in deionized water and blotted dry. The Vickers indenter test was again performed.

Fig. 1 – Sectioning of the tooth vertically in mesiodistal direction by means of slow speed diamond disk.

Sixty specimens formed were randomly divided into three groups of 20 teeth each: the teeth in the groups were treated as follows: Group 1 (control group) received no treatment. Group 2 was treated with remineralizing paste containing CPP-ACP (Tooth Mousse, GC Corporation, Fig. 3) and Group 3 was treated with remineralizing paste containing CPP-ACP with fluoride (Tooth Mousse Plus, GC Corporation, Fig. 4). These pastes were applied for 3 min (Fig. 5). Storage medium was artificial saliva (Fig. 6). This has been continued daily for seven days. After this remineralization process Vickers hardness was measured of all the specimens (Fig. 7).

Data obtained was statistically analysed.

3. Results

Student's t-test was used to compare the mean surface microhardness values between groups with a level of significance set at $p < 0.05$. The mean ($\pm$ SD) values and percentage changes in surface microhardness values at various stages are presented in Table 1. The mean percentage decrease in

Fig. 2 – Specimens immersed in carbonated drink.

Fig. 3 – Remineralizing paste containing CPP-ACP (Tooth Mousse, GC Corporation).

surface microhardness was 36.97% after the erosive challenge. All the remineralizing agents namely casein phosphopeptide-amorphous calcium phosphate with fluoride (CPP-ACPF, Tooth Mousse Plus), casein phosphopeptide-amorphous calcium phosphate (CPP-ACP, Tooth Mousse) and artificial saliva showed the remineralizing potential as the mean percentage surface microhardness increase was 38.98%, 30.52% and 6.02% respectively. The specimens treated with casein phosphopeptide-amorphous calcium phosphate (CPP-ACP, Tooth Mousse) and casein phosphopeptide-amorphous calcium phosphate with fluoride (CPP-ACPF, Tooth Mousse Plus) showed higher remineralization values in relation to those that were used in control group (artificial saliva) ($p < 0.05$). But the remineralizing potential of casein phosphopeptide-amorphous calcium phosphate with fluoride containing paste (CPP-ACPF, Tooth Mousse Plus) was significantly better than that of casein phosphopeptide-amorphous calcium phosphate containing paste (CPP-ACP, Tooth Mousse) ($p < 0.05$) (Table 2).

Fig. 4 – Remineralizing paste containing CPP-ACP with fluoride (Tooth Mousse Plus, GC Corporation).

Fig. 5 – Application of remineralizing paste for 3 min.

4. Discussion

Dental erosion is a relatively new risk factor for dental health, introduced by today's lifestyle. Demineralisation of tooth by erosion is caused by frequent contact between the tooth surface and acids. Extrinsic factors are related to frequent consumption of acidic foodstuffs or beverages and exposure to acidic contaminants in the working environment. In modern societies the extrinsic factor is becoming more important, due to the increased consumption of acid drinks as soft drinks, sport drinks, fruit juices and fruit teas.⁶

Therefore, it seems reasonable to search for effective agents for prevention or repair of these erosions.

Despite the wide use of fluoride, new agents to control erosion have been proposed and recommended for individual or professional-based application. These new remineralizing agents may contain calcium, phosphate compounds, like ACP, CPP-ACP, CPP-ACP with fluoride or bioactive glasses based on calcium sodium phosphosilicate compounds, known as Novamin (CSP).⁷

Fig. 6 – Storage of samples in artificial saliva.

Fig. 7 – Vickers microhardness tester.

So the present study aimed to compare the effect of casein phosphopeptide-amorphous calcium phosphate containing (CPP-ACP, Tooth Mousse) and casein phosphopeptide-amorphous calcium phosphate with fluoride containing remineralizing paste (CPP-ACPF, Tooth Mousse Plus) on dental erosion. The human enamel sections selected for the present study was taken from premolar teeth extracted for orthodontic purpose. The present study made use of Vickers Microhardness test for the measurement of initial enamel hardness, enamel softening as an early manifestation of the erosion process, as well as enamel hardening after remineralization.¹

For erosive challenge, the enamel specimens were exposed to carbonated drink for 14 min in order to simulate in vivo soft drink consumption pattern of seven days which resulted in 36.56% reduction in microhardness from baseline. This result is different from the study by Srinivasan et al (2010),⁸ in which the mean microhardness reduction was 24.5%.

While when the eroded enamel specimens were treated with different remineralizing agents i.e. CPP-ACP (Tooth Mousse) and CPP-ACPF (Tooth Mousse Plus), there has been significant increase in microhardness (Table 1). It has been

Table 2 – Intercomparison of remineralization potential of various remineralizing agents between various groups ($p < 0.05$).

Groups	Total no.	% Surface microhardness recovery	t-Value
Control	20	6.02 ± 1.90	10.487
CPP-ACP	20	30.52 ± 4.86	
Control	20	6.02 ± 1.90	12.79
CPP-ACPF	20	38.98 ± 5.46	
CPP-ACP	20	30.52 ± 4.86	2.38
CPP-ACPF	20	38.98 ± 5.46	

proposed that the remineralization mechanism of CPP-ACP involves localization of ACP at the tooth surface, which buffers free calcium and phosphate ions. By maintaining a state of supersaturation with respect to the hydroxyapatite, these ions depress demineralization and promote remineralization.⁹

However, the remineralization effect of CPP-ACP with fluoride (Tooth Mousse Plus) was found to be superior to that of CPP-ACP (Tooth Mousse) alone (Table 2). It is likely that a combination of CPP-ACP with fluoride resulted in co-localization of calcium and phosphate ions with fluoride ions at the enamel surface. Thus, it delivers all the ions required to build fluoroapatite crystals which are more resistant to dissolution by acids.¹⁰ Our results were in accordance with the findings of Srinivasan et al,⁸ (CPP-ACP with 900 ppm fluoride), Lussi¹¹ (CPP-ACP with 900 ppm fluoride) and Kumar et al,¹² (250–500 ppm fluoride dentifrice and CPP-ACP). These results suggest that the combination of CPP-ACP with fluoride exhibited higher remineralizing potential than CPP-ACP used alone.

In the present study, artificial saliva group also showed remineralization but it was least in comparison to other groups (6.02%). Many previous studies have pointed to the resistance to erosion of enamel surfaces by saliva. Enamel demineralization caused by acidic beverages has a tendency to reharder following exposure to saliva in the mouth (Amaechi and Higham 2001).¹³ It is speculated that, with its calcium, phosphate and fluoride content, saliva may be capable of remineralizing enamel erosion. However, due to lower concentration of calcium (1.0 mM/L), phosphate (4–5 mM/L) and fluoride (0.14–0.35 ppm), the recovery of microhardness was the lowest in the artificial saliva treatment group, compared to the other treatment group.

Furthermore, the present study was performed in the absence of an oral microbial environment or plaque accumulation on the tooth surfaces which may have resulted in

Table 1 – Mean values of surface microhardness at baseline level, after exposure to erosion and after treatment with remineralizing agents.

Groups	Total no. (N)	Baseline microhardness (VHN ± SD)	Microhardness after erosion (VHN ± SD)	% Decrease in microhardness (% ±SD)	Microhardness after remineralisation (VHN ±SD)	% Increase in microhardness (% ±SD)
Group 1 (control)	20	334.52 ± 28.24	211.78 ± 17.32	36.56 ± 4.048	217.26 ± 20.12	6.02 ± 1.90
Group 2 (CPP-ACP)	20	334.28 ± 28.46	2212.28 ± 10.98	36.26 ± 3.95	248.74 ± 11.93	30.52 ± 4.86
Group 3 (CPP-ACPF)	20	357.80 ± 20.50	273.32 ± 19.30	38.10 ± 3.60	273.32 ± 19.30	38.98 ± 5.46

decreased CPP-ACP adherence to tooth surfaces since CPP-ACP has been suggested to be incorporated into the plaque by binding to bacterial cell surfaces and to intercellular plaque matrix.¹⁴ So, further research using CPP-ACP and CPP-ACPF pastes with different approaches as preventive treatments using a model simulating the oral conditions with natural saliva and dental plaque as an in situ model are needed.

5. Conclusion

Within the limitations of low sample size and short-term nature of this in vitro study, CPP-ACP exhibited higher remineralizing potential when combines with fluoride than used alone. So CPP-ACPF (Tooth Mousse Plus) can be recommended to be used in preventing erosive tooth wear from acidic beverages.

Conflicts of interest

All authors have none to declare.

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