Iraqi Dental Journal Volume 45 – Issue 2 May. 2023

Remineralizing Effect of GC Tooth Mousse versus Acidulated Phosphate Fluoride on the Surface Microhardness of the Demineralized Enamel

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Submit: 14/4/2023 | **Accepted**: 20/5/2023 | **Published**: 25/5/2023

Abstract

Aims of the study: to assess the remineralizing of Acidulated Phosphate Fluoride and CG Tooth Mousse on the microhardness of enamel surface. **Materials and methods**: A total of (30) primary teeth from children aged 6-12 years were used in the study. After preparing enamel blocks then specimens were immersed in demineralizing solution in order to formation an artificial carious lesion. The enamel surfaces were treated with: Group1: (n=10) control negative on deionized water alone, group2: (n=10) CG Tooth Mousse and group3: (n=10) acidulated phosphate fluoride. Vickers surface microhardness test was used to measure the enamel's surface hardness at three different times: baseline, after demineralization, and after remineralization. **Results:** The microhardness of surfaces of all samples was decreased after immersion in demineralizing solution while after treatment with remineralizing agents showed increased in the surface microhardness measurements with statistically highly significant differences, GC Tooth Mousse superior remineralizing effect than APF. **Conclusions:** GC Tooth Mousse was better than APF in remineralizing effect and improving the surface microhardness of demineralized enamel for Primary Teeth.

Keywords: CG Tooth Mousse, Acidulated phosphate fluoride, Enamel Demineralization, Microhardness.

Introduction

Tooth enamel is one of the four main tissues that compose a person's tooth structure.[1] The entire anatomical crown of the tooth is covered in a very tough, thin, translucent layer of calcified tissue called enamel, the body's most mineralized tissue.[2]

The demineralization process of enamel is the dissolving and eventual loss of carbonated hydroxyapatite minerals from tooth structure as a result of a pH drop in the oral environment.[3] The degree of mineralization is strongly correlated with enamel translucency, so the first signs of enamel demineralization sometimes manifest clinically as a "white spot lesion" which often take the form of chalky white patches on the tooth surface.[4] Demineralization process can be reversed through remineralization when the microenvironment has a pH greater than 7.0 and calcium and phosphate ions are readily available.[5–7]

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Remineralization is a process that occurs naturally to repair damage and return minerals to the hydroxyapatite (HAP) crystal lattice in ionic forms. When calcium and phosphate ions from saliva fluid and plaque are re-deposited within the caries lesion under nearly neutral physiological pH conditions, fresh HAP crystals are formed that are bigger and more resistant to acid disintegration.[8]

The development of approaches for the non-invasive therapy of early caries lesions by remineralization to maintain tooth structure has become the primary focus in caries research in recent years.[9] Commercially accessible remineralizing agents with fluoride, phosphate and calcium ions come in a variety of forms and concentrations.[10]

For many years, the main method used by humans to prevent dental cavities was topical fluoride. It benefits through a variety of methods, including reducing pathology, promoting remineralization, and preventing microbe maturation.[11] When various fluoride sources (such as fluoride toothpaste, fluoride lozenges, fluoride mouthwash, fluoride gel, fluoridated salt, etc.) are combined, the chance of developing dental fluorosis or other negative effects increases in children, especially.[12,13]As a result, another remineralizing agent known as CPP-ACP, a milk protein derivative, was commercially marketed because it has been shown to have anticariogenic benefits.[14]which is a new bioactive substance can act as a storehouse for bioavailable calcium and phosphate, promoting their precipitation on the surface of enamel and successfully enhancing remineralization.[14]

Materials and Methodologies

Materials

1.GC Tooth Mousse: 10% Casein Phosphopeptide–Amorphous Calcium Phosphate (CPP-ACP).

2.Acidulated phosphate fluoride gel (APF): 1.23% fluoride.

Ethical Aspect:

The Local Ethics Committee of the College of Dentistry at the University of Mosul in Nineveh, Iraq, (UoM.Dent / H.DM.72/ 22) Research Ethics Committee reviewed and approved the study protocol before it was carried out in vitro.

Sample Collection and Preparation

After excluding the carious teeth, a total of 30 samples primary molars collected from patient between 6-12 years old were obtained from Left Bank dental special centers and several private clinics in Mosul city, the teeth were retained deciduous molars. The crown was normal without any caries, fractures, cracks, white spot lesions, hypoplasia and fluorosis any sample with abnormality was excluded from the study after being used OPTIKA stereomicroscpe and checked the enamel surface.

After the teeth were thoroughly cleaned and polished using a rubber cup, non-fluoridated pumice, and a slow-speed handpiece, the roots were cut 2 mm below the cement-enamel junction by using a diamond straight bur and a high-speed handpiece utilizing constant water cooling to prevent damage to the enamel.[15,16]

The coronal regions of the samples were then embedded in blocks of auto polymerized self cure acrylic resin with the outer buccal side facing upward using cylindrical plastic tubes (14 mm in height) that had been prepared and cut with parallel and flat upper and lower borders. To create uniform flat enamel surfaces for the surface microhardness test, the surfaces of enamel were ground wet with (400 and 600) grit silicon carbide abrasive paper for standerization.[17]

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Preparation of Demineralization Solution

Chemicals were used to prepare the demineralizing solution in accordance with the laboratory's general safety guidelines, which were according to Abdelaziz *et al*. (2019) consisted from (0.05 M) acetic acid, (2.2 mM) $CaCl_2$, (2.2 mM) KH_2PO_4, with KOH (1 M) modifying pH (4.4).[18]

Formation of an Artificial White Spot Lesion

All samples were soaked in the demineralizing solution for 48 hours (2days) at 37 °C and check the development of a white spot lesion and after 48 hours all samples were removed and washed with deionized water as a modification to the method that described Abdelaziz *et al*. (2019).[18] Inorder to prevent solution depletion, the demineralizing solution was changed every 12 hours.[19]

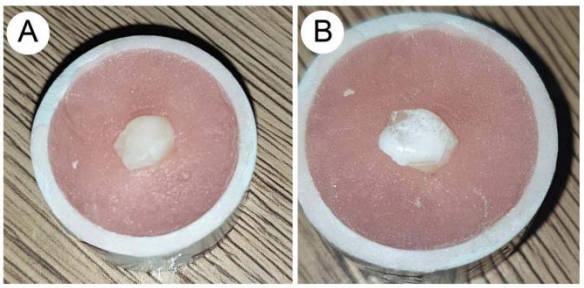

Figure 1: (A) Sound enamel sample before soaked in demineralizing solution, (B) Formation of artificial white spot lesion.

Grouping and Cycle of Treatment

The total number of "thirty teeth" were divided randomly into three groups. Each group contain ten samples, after formation of artificial white spot lesion were subjected to the following treatments within 6 days.

Group 1 (Control negative group): n=10 the tooth samples were stored in deionized water until being subjected to tests of microhardness.

Group 2 (GC Tooth Mousse): n=10 the surfaces of enamel were treated twice daily for 14 days by applying a thin layer of GC Tooth Mousse with a fine brush, waiting 5 minutes, and then washing with deionized water.[20]

Group 3 (1.23% Acidulated Phosphate Fluoride): n=10 the surfaces of enamel were brushed with 1.23% APF gel for 4 minutes once a week for 4 weeks. Samples were immersed in deionized water and stored at 37°C between fluoride applications.[21]

Vickers Microhardness Test

At Mosul Technical Institute/North Technical University, a Vickers microhardness machine (OTTO WOLPERTWERKE GMBH, V-Tester 2/ Germany) was used to measure the microhardness of the enamel surface of the teeth, the same examiner used the same calibrated device to take all readings. By applying a 500 gram load about 15 seconds, which remained constant across the whole research and for all samples, the microhardness of the teeth's middle third of the labial surface was assessed. To assure measurement accuracy, three indentations were produced on the enamel's flattest points. Each indentation's length was then measured microscopically with a 70x lens, and one reading was created for each sample by calculating the mean value of these three indentations.[22, 23]

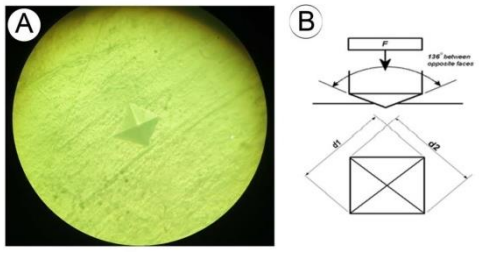

Figure 2: (A) An Image of a Diagonal Indentation of Vickers Technique, (B) A diagram of the Vickers process, which makes a square indentation on the surface using a 136° diamond pyramid indenter on a microhardness tester.[24]

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The indentation results can be seen as a rhomboid-shaped shadow on the projector screen. A microscope was used to determine the indentation's diagonal length in microns. According to Hegazy and Mubarak (2012)[25] the following equation was used to translate the Vickers values into microhardness values:

$VHN = 1.854 * P / d^2 = (kg / mm^2)$

P represents the loading of test in grams.

d represents the indentation's diagonal line's length in microns.

Results

The descriptive statistic of the three groups was shown in Table 1. It includes; number of samples, mean, standard deviations, minimum and maximum. After using one way ANOVA, the result of current study showed no statistically significant differences at baseline and after demineralization while statistically, highly significant differences after remineralization at ($P < 0.01$) Table 2.

Table 3 showed Duncan Multiple range test as the highest mean in the GC group then APF group compared to control negative group.

Table 1: Descriptive statistic of all groups at baseline, after demineralization and after remineralization

	Groups	N	Mean	± Standard deviation	Minimum	Maximum
Baseline	Control negative	10	292.94	33.56	241.16	342.82
	GC	10	292.94	33.56	241.16	342.82
	APF	10	300.74	47.61	241.16	370.80
	Total	30	295.54	37.63	241.16	370.80
After demineralization	Control negative	10	110.26	14.10	92.70	137.86
	GC	10	110.78	14.37	92.70	137.86
	APF	10	117.53	14.24	92.70	134.56
	Total	30	112.86	14.15	92.70	137.86
After remineralization	Control negative	10	110.26	14.10	92.70	137.86
	GC	10	251.69	19.04	226.31	295.59
	APF	10	229.35	17.77	206.50	257.50
	Total	30	197.10	65.26	92.70	295.59

Table 2: One Way ANOVA test for surface microhardness of control negative, GC Tooth Mousse and APF groups

Groups		Sum of Squares	Df	Mean Square	F	Sig.
Baseline	Between Groups	405.28	2	202.64	.135	.875
After demineralization	Between Groups	329.17	2	164.58	.811	.455
After remineralization	Between Groups	115615.09	2	57807.54	197.585	.000*

* statistically highly significant difference at $p \leq 0.01$.

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Table 3: Duncan test for surface microhardness after remineralization

Groups	N	1	2	3
Control negative	10	110.260		
APF	10		229.353	
GC	10			251.690

Discussion

The surface microhardness test (SMH) measures the resistance of materials against plastic deformation from a standard load source which allows reproducible measurements of the same specimen over time and minimizing the experimental variation.[26] As the number of minerals present in the tooth structure is shown by the numerical hardness values. SMH has been used to measure the mineral loss and gain in tooth tissues as a result demonstrating that SMH analyses are a practical and trustworthy method for determining how the mineral alterations caused by the enamel's demineralization and remineralization cycles are being assessed.[27] The enamel surface's microhardness is a good indicator of the mineral content of the enamel, and measuring microhardness is sensitive enough to evaluate enamel resistance to demineralization. Also, a significant link between mineral loss in enamel lesions and the enamel's surface microhardness was made.[28] The result of current study when comparing the data obtained after demineralization to those obtained after the administration of the remineralizing agents revealed a statistically significant difference in enamel SMH in each group. Both treated groups showed a significant increase in the microhardness which indicates remineralization with superior remineralizing effect of GC Mousse over APF. For AFP group, increase in the microhardness because fluoride had been the most favored remineralizing agent especially its acidulated forms. In our investigation, the APF gel group showed the remineralization impact on the demineralized lesion, which may indicate that the APF gel consistency and viscosity permit extended contact with the surface of enamel, allowing it to deeply penetrate the demineralized areas.[21] The identical result for CPP-ACP group increase in the microhardness. This increase maybe due to the protection effect of a direct chemical action of the concentration of phosphoprotein and calcium phosphate. Thus, Amorphous calcium phosphate nanoclusters are formed when casein phosphopeptide binds calcium and phosphate ions. Within the subsurface lesion concentration, these casein phosphopeptides - stable amorphous nanoclusters of calcium phosphate (CPP-ACP) can maintain high calcium and phosphate ion gradients and ion pairs. As the ion concentration in the lesion fluid rises, hydroxyapatite or fluorapatite is formed through crystal formation, minimizing enamel demineralization, and promoting remineralization.[29]

The current study's findings are similar to what Ma *et al.* found that CPP-ACP had a great remineralization effect on white spot lesions, with large percentages of lesions regressing and a

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high recovery of surface microhardness.[30] while finding disagrees with that of Vyavhare *et al*. study, who it can be used in conjunction with fluoride but should not be used in place of it.[31]

Conclusions

GC Tooth Mousse and APF had remineralizing effect and improving the surface microhardness of demineralized enamel for primary teeth, but GC Tooth Mousse was a superior.

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