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Comparison of the Effect of Fluoride Varnish and GC Tooth Mousse on Enamel Hardness in Primary Dentition

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Abstract

Background: Caries causes progressive demyelination in the tooth structure. This study was conducted to address concerns regarding the decay of milk teeth, which are important for children's growth and nutrition. Therefore, the aim of this study is to compare the effects of fluoride varnish and GC tooth mousse on the enamel hardness of milk teeth.

Methods: In this laboratory study, 36 human primary mandibular incisors were included. The samples were subjected to a hardness test (50 grams, 10 hours) after proper cleansing (primary measurement). Then the samples were randomly divided into 3 groups as follows (N=12): the GC tooth mousse group, the fluoride varnish group, and the control group. The teeth were exposed to the test materials based on their group and their hardness was measured (secondary measurement). Finally, each group was placed in acetic acid for 6 hours, and the hardness was measured for the third time (tertiary measurement). Data were analyzed using SPSS V.22.

Results: The findings showed that the enamel resistance after exposure to fluoride varnish and GC tooth mousse was 471.86 and 405.45, respectively. However, after exposure to acid, the resistance was reduced to 291.5 and 233.66 in the fluoride varnish and GC tooth mousse groups, respectively. The highest resistance was observed in the fluoride varnish, GC tooth mousse, and control groups, respectively. The enamel resistance in the fluoride varnish and GC tooth mousse groups was 82.2 and 38.99 units higher than in the control group, respectively. This difference was statistically significant (P=0.001).

Conclusion: The results of this study indicat that both fluoride varnish and GC tooth mousse increased enamel resistance. However, fluoride varnish showed better outcomes compared to GC tooth mousse.

Key Words: Primary teeth, Enamel, Caries, Fluoride, Hardness .

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1- INTRODUCTION

Dental caries, a common chronic infectious condition in childhood, is primarily caused by the fermentation of carbohydrates by oral microorganisms such as Streptococcus mutans. This process leads to the destruction of enamel and dental fillings. Dental caries is influenced by various factors including bacterial, host-related, and dietary elements. The disease's transmissibility can result in the deterioration of enamel and dentine due to acid produced from bacterial activity. Although dental caries has decreased in most developed countries in recent years, it remains a major public health concern, especially among children (1, 2).

This condition develops with the demineralization of the inorganic components of the tooth, subsequently leading to the degradation of the organic matrix and resulting in progressive demineralization of the dental structure. Demineralized enamel has increased porosity compared to healthy enamel, which is characterized by a distinct difference in refractive index (3). Consequently, this disparity leads to enhanced light scattering within demineralized enamel, rendering its appearance whiter than that of intact enamel. The processes of demineralization and remineralization of dental tissues are dynamic and are in equilibrium throughout life. When the rate of demineralization is more than remineralization, minerals within the tooth tissues dissolve, facilitating the development of carious lesions. Conversely, when remineralization exceeds demineralization, the progression of decay may be reversed, allowing for the restoration of tooth mineral content (4, 5).

To maintain this balance between demineralization and remineralization, it is essential to ensure the presence of calcium, phosphate, and fluoride ions within the oral cavity. Calcium is the primary natural substance in the formation of dental structures. Consequently, various calcium derivatives exhibit remarkable potential for application in treating dental disorders, attributable to their biocompatibility and biodegradability. Given that the remineralization capacity of saliva is constrained by the availability of calcium, the addition of calcium and phosphate ions from sources such as varnishes can facilitate the remineralization of primary carious lesions. As a result, numerous manufacturers have endeavored to enhance the efficacy of fluoride varnishes through the addition of calcium and phosphate ions (6, 7).

A recent study suggested that GC Tooth Mousse is more effective than fluoride varnish in reducing dentinal hypersensitivity (8). On the other hand, another study suggested fluoride varnish has a better outcome than GC Tooth Mousse (9). It should be mentioned that both studies were conducted on adults and no similar study was found on primary dentition to solve the controversies.

Considering the critical role of primary teeth in the growth and nutritional development of children, alongside parents' concerns regarding the caries of these teeth, the current investigation was conducted to examine the impact of fluoride varnish and GC Tooth Mousse on reducing decay in primary dentition.

2- MATERIALS AND METHODS

This laboratory study was conducted by the research committee of the Faculty of Dentistry at Mazandaran University of Medical Sciences (IR.MAZUMS.REC.1401.09). Primary human mandibular incisors that were extracted due to crowding, mobility, or trauma were included in this investigation. Teeth with caries, cracks, calcification, demineralized lesions, and structural deformities were excluded (10).

Tuloglu et al. worked on 24 samples and reported the mean tooth hardness in MI Varnish and Clinpro White groups to be 23.6±3.36 and 29.85±3.27, respectively (11). The sample size was calculated to be 12 samples in each group based on their study, and considering the significance level (α) of 0.05, the test power of (1-β) 95%, as well as the following formula:

$$n = \frac{(z_{1-\alpha/2} + z_{1-\beta})^2 * ({\sigma_1}^2 + {\sigma_2}^2)}{(\mu_1 - \mu_2)^2}$$

The samples were kept in 0.9% normal saline, which was changed weekly (12). The crowns were cut 5 mm below the cementoenamel junction (CEJ) and polished with pumice powder and a rubber cup. Since the intact surface of the enamel has some fluoride and the lower layers are more resistant to acids, the samples were polished with 1000, 800, and 600-grit silicon carbide paper plates. Subsequently, the teeth were mounted in clear acrylic blocks. A paper sticker was placed on the labial surface of the teeth, measuring 4 x 4 mm, and the surrounding area was covered with nail polish, then the sticker was removed and the excess glue was washed with gas and water (13).

All samples were placed in artificial saliva (Nik Seram Razi, Iran) one hour before the test to simulate the oral environment. The Vickers hardness test was conducted with the microhardness device (Kopa Research Company, Mazandaran, Iran) on 3 points of the sample using a force of 50 grams for 10 hours, applied by a pyramidal diamond indenter. The average of these 3 points was considered as the baseline (primary hardness).

Then the samples were randomly divided into three equal groups of 12 as follows:

1. The GC Tooth Mousse group: GC Tooth Mousse paste was applied to the tooth surface for 3 minutes using a cotton applicator. The additional paste was removed and the samples were kept in artificial saliva

2. The fluoride varnish group: The fluoride varnish was applied to the samples for 60 secends, and the samples were kept in artificial saliva.

3. The control group: The samples were kept in artificial saliva to simulate the oral environment.

The hardness test was taken from the samples (secondary hardness). Each group was placed in acetic acid (pH = 4.4) for 6 hours. After removing the teeth from the solution, they were washed with distilled water and the hardness of each sample was remeasured at 3 points on the same surface (tertiary hardness). The average values were recorded and compared with the initial numbers. All procedures were performed by a final-year dental student under the supervision of a pedodontist.

Descriptive information was reported using mean, median, standard deviation, minimum and maximum indicators. To check the normality of average tooth enamel resistance, the Shapiro-Wilk test was used and the results showed that this hypothesis is valid. Independent t-tests and analysis of variance were used to compare the average tooth enamel resistance between the groups, and paired t-tests and repeated measures were used to compare the average tooth enamel resistance at diffrent measurement times. To simultaneously control the effect of group and time on the average resistance of tooth enamel, the Generalized Estimating Equations (GEE) model was used. SPSS 22 software was used for analysis and a significance level of less than 0.05 was considered.

3- RESULTS

This laboratory study included 36 primary mandibular incisors divided into three groups: the GC Tooth Mousse group, the fluoride varnish group, and the control group. The findings suggested that the average enamel hardness after exposure to fluoride varnish and GC Tooth Mousse was increased (471.86 and 405.45, respectively). Howerer, the hardness after acid exposure was reduced in all three groups (Table 1).

Both fluoride varnish and GC Tooth Mousse groups had significant differences from the control group in terms of enamel hardness. The mean hardness in the fluoride varnish and GC Tooth Mousse groups was 82.2 and 38.99 units higher than that in the control group, respectively. Also, the mean hardness in the second and third time was 63.93 and 136.63 units higher than the first time, respectively (Table 1).

According to Table 2, there was no significant difference between the three groups in the average level of enamel hardness in the first measurement ($P<0.05$). In the second time, the average enamel hardness was significantly higher in the fluoride varnish group ($P=0.001$).

Table-1: The average enamel hardness in the groups before and after the intervention.

Groups		1st	2nd	3rd	P value
GC tooth mousse	Mean	347.56	405.45	233.66	0.001>
	Sd	34.74	21.68	21.29	
	Min	325.5	359.1	182.1	
	Max	384.3	438.8	287.9	
Fluoride varnish	Mean	352.92	471.86	291.50	0.001>
	Sd	24.46	55.74	43.63	
	Min	310.10	419.2	207.4	
	Max	395.3	597.1	369.1	
Control	Mean	363.1	-	128.52	0.001>
	Sd	20.13	-	26.25	
	Min	326.1	-	89.3	
	Max	395.6	-	185.1	

Table-2: Comparison of the mean enamel hardness among the groups in the 1st, 2nd, and 3rd measurement.

Time	Group		Hardness	P value
1st measurement	Fluoride varnish	Mean	352.92	0.229
		Sd	24.46	
	GC tooth mousse	Mean	347.56	
		Sd	21.29	
	Control	Mean	363.1	
		Sd	20.13	
2nd measurement	Fluoride varnish	Mean	471.86	0.001
		Sd	55.74	
	GC tooth mousse	Mean	405.45	
		Sd	21.68	
3rd measurement	Fluoride varnish	Mean	291.5	0.001>
		Sd	43.63	
	GC tooth mousse	Mean	233.66	
		Sd	34.74	
	Control	Mean	128.72	
		Sd	26.25	

In the third measurement, the fluoride varnish group had the highest hardness, followed by the GC Tooth Mousse group and the control group ($P<0.001$). Two-by-two comparison of the groups showed a significant difference between all three groups and the highest hardness was in the fluoride varnish, GC tooth mousse, and control groups, respectively (Figure 1).

4- DISCUSSION

Dental caries is characterized by a multifactorial etiology, resulting from the interaction of microbial factors, dietary influences, host, and time aspects. The use of preventive strategies is instrumental in inhibiting the progression of caries and in reducing treatment costs. Notably, these methods offer the advantage of preserving tooth structure while being more economical and eliminating the need for specialized and costly equipment (14, 15). Various laboratory and clinical studies have demonstrated that different products containing topical fluoride yield positive outcomes in the prevention of tooth decay (16, 17).

The effects of fluoride can be categorized into local and systemic influences. Systemic benefits are attained through the consumption of fluoridated water and foods or a diet supplemented with fluoride. Conversely, the local effects of topical fluorides are achieved by direct contact with fluoride-containing products such as toothpastes, mouthwashes, gels, foams, and varnishes (18, 19).

Enamel is produced by ameloblasts, which derive from the ectodermal embryonic layer. Chemically, enamel is characterized by a crystalline structure composed predominantly of minerals, consisting 95-98% of its weight as inorganic matter. The remaining composition consists of approximately 1-2% organic components and about 4% water by weight. The enamel matrix contains millions of enamel prisms, which represent its principal structural element. The prisms are dense together and extend in a wave-like and intertwined way from the junction of dentin and enamel to the outer surface of the tooth, a configuration observable in both primary and permanent dentition (20, 21).

Enamel hardness in primary dentition is a critical factor in pediatric dentistry and has significant implications for dental health, treatment planning, and the prevention of caries. This study aimed to compare the effects of fluoride varnish and GC Tooth Mousse on enhancing the enamel resistance of primary teeth to demineralization. The findings suggest that, following fluoride exposure, the average enamel resistance at the second stage was measured at 471.86, while the resistance after exposure to GC Tooth Mousse was 405.45, demonstrating the superior efficacy of fluoride.

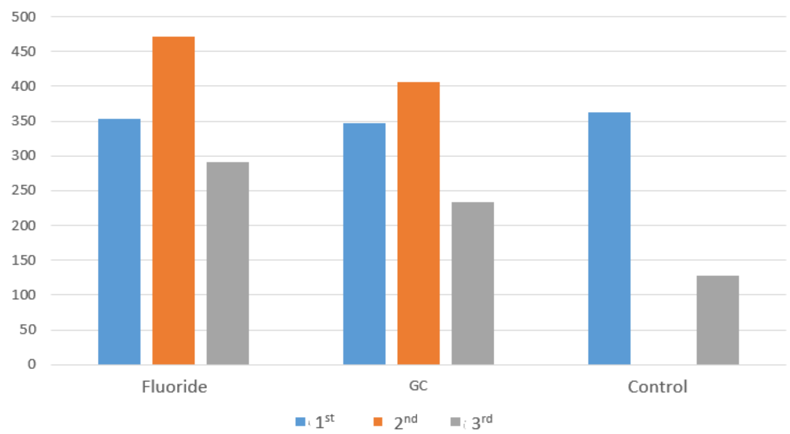

Figure-1: The average enamel hardness in the groups before and after the intervention.

In the third stage, after acid exposure, the fluoride varnish group exhibited a resistance of 291.5, compared to 233.66 for the GC tooth mousse group. In contrast, the control group displayed a significantly lower resistance of 128.52 after acid exposure, highlighting the enhanced protective effect of both fluoride varnish and GC tooth mousse compared to the control group. This study reports that fluoride confers a significantly greater resistance than GC Tooth Mousse.

In line with these findings, an investigation conducted by Sufi et al. assessed enamel resistance across five different groups and found that the lowest caries depth was associated with a 0.05% fluoride solution, followed by a combined fluoride-chlorhexidine mouthwash, a 2.0% chlorhexidine solution, green tea polyphenol extract, and normal saline, which exhibited the highest decay depth. Notably, the depth of decay observed after exposure to fluoride-chlorhexidine solutions and the 0.05% fluoride solution demonstrated statistically significant differences when compared to results obtained from green tea polyphenol extract and normal saline. However, no statistically significant differences were noted among the decay depths in the three experimental groups utilizing fluoride-chlorhexidine solutions, reinforcing the notion that fluoride effectively prevents decay and enhances enamel resistance (22). Furthermore, existing literature on caries reduction indicates that sodium fluoride varnish is comparably effective to, or even more effective than, APF gel in promoting enamel resistance (23, 24).

In the two-by-two comparisons of the groups, significant differences were observed among all three groups, with the highest enamel resistance recorded in the fluoride varnish group, followed by the GC tooth mousse group, and finally the control group. Rirattanapong et al. noted that fluoride varnishes containing tricalcium phosphate effectively prevent the early development of primary enamel lesions, and no significant differences in efficacy were found among the tested groups (25). In this study, a combination of fluoride and tricalcium phosphate was utilized, aligning with the findings of Rirattanapong et al.; however, no significant relationships were found between the groups, despite the presence of fluoride compounds in all experimental groups, excluding the control.

Comparing the results across three different times suggested that the average enamel resistance varied significantly among the fluoride varnish and GC tooth mousse groups across three measurements, as well as within two measurements of the control group. Specifically, in the fluoride varnish and GC tooth mousse groups, there was an increase in enamel resistance at the second stage of measurement; however, following acid exposure, this resistance diminished. The most pronounced decrease in resistance was observed in the control group. Kaur et al. Conducted a study examining the remineralizing impact of casein phosphopeptide-amorphous calcium phosphate (CPP-ACP), silver diamine fluoride, and fluoride varnish on the enamel surface of primary and permanent teeth. They reported that all these agents had acceptable anti-decay properties by enhancing remineralization (26).

In a concurrent analysis of group and temporal effects, both the fluoride varnish and GC tooth mousse treatment groups exhibited significant differences in tooth enamel resistance when compared to the control group. Specifically, the average resistance of tooth enamel in the fluoride varnish and GC tooth mousse groups was found to be 82.2 and 38.99 units higher than that of the control group, respectively. Additionally, the average resistance of tooth enamel at the second measurement was 63.93 units greater than at the first measurement, while at the third timepoint, it decreased by 136.63 units compared to the first measurement. Tuloglu et al. conducted a study involving four groups: no treatment (control), MI paste (comprising 1 to 8% sodium fluoride and 1 to 5% CPP-ACP), Clinpro White (containing 1 to 5% sodium fluoride and less than 5% tri-modified calcium phosphate), and Duraphat (with less than 5% sodium fluoride). Their findings indicated that the MI paste group exhibited the least changes in surface hardness and lesion depth, followed by Clinpro White, Duraphat, and the untreated control group. Consistent with the present study, a statistically significant difference was noted in both microhardness levels and lesion depth across all groups. This laboratory study suggests that CPP-ACP fluoride varnish is more effective in enhancing the acid resistance of primary enamel compared to other fluoride varnishes (11). These findings support the conclusion that fluoride-containing products can play a crucial role in preventing dental caries and enhancing the resistance of tooth enamel.

5- CONCLUSION

The results of the present study showed that fluoride varnish had proper function compared to the other two groups. Although GC tooth mousse showed an acceptable increase in the enamel hardness, it was weaker than fluoride varnish. All in all, both fluoride varnish and GC tooth mousse were significantly more effective than the control group.

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