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Research Paper: Effect of Different Fluoridated Toothpastes on the Enamel Microhardness of Primary Teeth

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ABSTRACT

Introduction: Using fluoridated toothpaste is the most feasible and common form of applying fluoride. Fluoride absorption could increase tooth microhardness. Therefore, the present study aimed to investigate the changes of primary tooth enamel microhardness following KAM, BATH, and CREST pediatric toothpaste use.

Materials and Methods: In total, 45 healthy primary molar teeth were randomly divided into three 15-membered groups. The microhardness of samples was measured before the test (step 1). Each sample was immersed into 5mL of 1% stirred citric acid; then, in 10 mL of 1%, unstirred citric acid for 15 minutes, and microhardness was re-measured (step 2). Then, the samples were immersed in the suspension of three different toothpaste types (5 g toothpaste +10 mL artificial saliva). Microhardness was re-measured 10 days later (step 3). Analysis of Variance (ANOVA) and Tukey test were applied for statistical analysis.

Results: Demineralization decreased the surface microhardness of enamel (P=0.001). Moreover, the surface microhardness recovery was significant in all groups (P=0.001). The greatest recovery in microhardness after the treatment with toothpastes belonged to KAM toothpaste; however, there were no significant differences between surface microhardness produced by the three toothpastes.

Conclusion: There was no significant difference in microhardness changes after applying KAM (MFP, 200 ppm), BATH (MFP, 132 ppm) and CREST (NaF, 500 ppm) toothpastes. Thus, the use of Iranian pediatric toothpastes, which are inexpensive and have lower concentration of fluoride, are recommended.

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1. Introduction

Dental caries are among the most frequent chronic childhood diseases [1]. The most cost-effective way to prevent tooth decay is brushing with fluoridated toothpastes [2, 3].

Fluoride helps with the remineralization and reduces the cariogenic effect of bacteria on teeth [4]. In lower concentrations, fluoride enables the constant reposition of mineral compounds which are lost during acids attack on the enamel and fluorapatites formation, which are less susceptible to acids. Higher concentration of fluoride leads to calcium fluoride formation; i.e. a reservoir of fluoride [5]. Fluoride effect can be measured by microhardness level. There are several methods to measure it, such as microhardness changes, spectrophotometer, X-Ray, dye penetration, and densitometry [6, 7, 8].

Different fluoride formulations, such as sodium fluoride, sodium monoflurophosphate, and amine fluoride are used as fluoride ions carriers in toothpastes. This in vitro study was designed to compare the surface microhardness changes of enamel, following the use of KAM (MFP, 200 ppm), BATH (MFP, 132 ppm), and CREST (NaF, 500 ppm) pediatric toothpaste.

2. Materials and Methods

This in vitro experimental study was performed on 45 sound primary molars extracted due to orthodontic purposes. The study samples were selected through convenience sampling method. The study samples were stored in tapped water at room temperature. They were polished with pumice and distilled water for 10 seconds; then, mounted in a particular transparent self-cured acrylic frame. To evaluate the transparent appearance of enamel surfaces, we examined surfaces under light microscope (Siemens, Germany) using X 100 objective lens. Buccal surfaces of the teeth were used, and other surfaces were covered with nail polish. Microhardness was measured by Vickers microhardness instrument (made in, Germany Gmbh), in three steps.

The study samples were randomly assigned into three groups, as follows: BATH, KAM, and CREST toothpaste groups. The detailed information of toothpaste types is presented in Table 1. The microhardness of samples was also measured. A force of 200 g/10 secs was applied in three-point distances of 500, 1000, 1500 micrometers on each sample. Furthermore, the mean value of the three points was obtained as the standard reading. Then, each sample was primarily immersed in to 5m of 1% stirred citric acid for 6 minutes. Next, they were immersed into 10 mL of 1% unstirred citric acid for 15 minutes. After that, microhardness was re-measured.

In the third step, after measuring the PH of toothpaste, the samples were inserted in the suspension of toothpaste (5 g toothpaste +10 mL artificial saliva) for 2 minutes. The daily cycling regimen comprised of 3x1 min acid challenges and 2x2 min treatment periods. After rinsing with distilled water and replacing into artificial saliva, microhardness was re-measured 10 days later by a person who was blind to teeth classification. Analysis of Variance (ANOVA) and Tukey's test was used for data analysis.

3. Results

Demineralization decreased the surface microhardness of enamel (P=0.001). After exposure to the suspension of toothpaste, the highest and lowest microhardness levels belonged to KAM and CREST toothpaste, respectively (Table 2). We applied ANOVA to evaluate the changes in surface microhardness in three groups. The relevant data suggested a significant increase in microhardness 10 days after intervention (step 3), compared to the demineralization phase (step 2) in all groups (P=0.001) (Table 2). We used Tukey's test for paired group comparison. The obtained data revealed no significant difference between surface microhardness produced by the three different toothpastes (Table 3).

Table 1. Details of toothpaste used in this study

Toothpaste	Type of Fluoride	Fluoride Content (PPM)	PH	Abrasive
KAM	Sodium monofluorophosphate	200	7	Hydrated silica
BATH	Sodium monofluorophosphate	132	7	Hydrated silica
CREST	Sodium fluoride	500	8	Hydrated silica

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Table 2. Comparing the microhardness of samples using ANOVA

Toothpaste	Mean±SD		P
	After Demineralization	Ten Days After the Intervention	
KAM	153.990±42.0426	234.398± 48.8427	0.001
BATH		220.725± 33.4577	
CREST		215.555± 64.8818	

Table 3. Paired group comparison of microhardness using Tukey's test

Toothpaste Group	Toothpaste Group	P
KAM	CREST	0.204
	BATH	0.432
CREST	BATH	0.886

4. Discussion

The study results indicated that the greatest and lowest recovery of microhardness belonged to KAM and CREST toothpastes, respectively; however, this difference was not significant.

In this study, intact primary molars were collected from Tehran residents in district 2. Because of the difference in dental composition and their effect on fluoride absorption rate, it was better to select the samples from a similar region. In other words, people's residential location and drinking water fluoride content must have been controlled.

We only considered an aspect of the buccal surface of each tooth; because of the treatment limitations on a particular surface in each tooth might eliminate the disrupting effects [9, 10].

In the current study, the studied teeth were preserved in tap water, and no antiseptic solution was used; because chemical compounds affect the enamel microhardness, as confounding factors [11]. In the study by Saliva et al. , preserving samples in 0.01% thymol solution and 2% formaldehyde resulted in the microscopic changes of tooth structure, and the enamel became more susceptible to demineralization [12].

In the study by Lee et al. crowns were separated from root by diamond rotary disk [3]. In this method, the stress of cutting could be a confounding factor and might affect the mechanical properties of enamel. Thus, we did not separate the crown from root.

Haung et al. used enamel blocks without crown support. In the Vickers method, force is applied to samples; then, microhardness is measured [13]. It is expected that these forces be better-tolerated if samples are equipped with crown support.

Wefel et al. argued that acidic fluoride causes the further enhancement of enamel microhardness compared to non-acidic fluoride [14]. Jabbari, far et al. used non-acidic toothpaste with equal pH [15]. In the current study, similarly, non-acidic toothpaste was used. The pH of BATH and KAM was 7, and the pH of CREST was 8.

In the current study, comparing KAM (MFP,200 ppm) and BATH (MFP,132 ppm) toothpaste, KAM toothpaste, with higher fluoride concentration resulted in higher increase of microhardness. Additionally, KAM (MFP,200 ppm) and BATH (MFP,132 ppm) toothpaste increased microhardness more than CREST (NaF,500 ppm), toothpaste. This is probably due to the interaction of ingredients, inconsistent distribution, solubility of fluoride, and different pH values of studied toothpaste [15].

Chaudhary et al.suggested that fluoride-free toothpaste increased microhardness more than those with monofluorophosphate [10].

Jabbarifar et al. found no significant difference in microhardness changes after applying CREST (500 ppm), POUNE (500 ppm), and fluoride-free POUNE toothpastes [15]. CREST toothpaste (1100 ppm) increased microhardness more than CREST (500 ppm) and POUNE (500 ppm).

According to Casal et al. the effect of 1400 ppm toothpaste, compared to fluoride-free toothpaste was not statistically significant due to inappropriate fluoride release [16]. Doga et al. revealed that 226 ppm toothpastes increased enamel remineralization more than 450 ppm and 900 ppm toothpastes [17].

Craig et al. documented that a sodium fluoride toothpaste (1150 ppm) increased microhardness more than Crest toothpaste (sodium fluoride 1100 ppm) and placebo [18]. Sodium fluoride toothpastes (1450 ppm) increased microhardness more than Eelmex sensitive toothpaste (1450 ppm) and placebo.

A limitation to the present study was that other toothpaste ingredients might lead to variations in the surface microhardness of enamel. Inappropriate conditions, like components of natural saliva and oral cavity were other limitations of the study.

5. Conclusion

The study results suggested no significant difference in microhardness changes after applying KAM, BATH, and CREST toothpaste. Therefore, using Iranian-made pediatric kinds of toothpaste, which are inexpensive and have lower concentration of fluoride are recommended.

Ethical Considerations

Compliance with ethical guidelines

There is no ethical principle to be considered doing this research.

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Authors contribution's

The authors declared no conflict of interest.

Conflict of interest

There are no conflicts of interest to be declared.

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