Indian Journal of Science and Technology, Vol 9(44), DOI: 10.17485/ijst/2016/v9i44/105116, November 2016
ISSN (Print) : 0974-6846
ISSN (Online) : 0974-5645

Surface Changes in Primary Teeth after the Application of Children's Fluoride Toothpaste to Prevent Early Childhood Cavities

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Abstract

Objectives: To evaluate the effect of primary teeth with children's fluoride toothpaste on enamel remineralization. **Methods/Statistical Analysis**: Sixty enamel specimens were divided into three groups as follows: Group 1 served as the control group, in Group 2, children's toothpaste without sodium fluoride (NaF) was applied to the teeth three times a day for three min, and in Group 3, children's fluoride toothpaste (0.243% NaF) was applied to enamel for four weeks. Each primary tooth surface was measured by scanning electron microscopy (SEM; JSM-6300, JEOL, Japan). **Findings**: The children's toothpaste containing 0.243% NaF promoted the enamel remineralization of the tooth surface from three weeks of treatment. When the surfaces of primary teeth were examined, the surfaces of teeth treated with toothpaste containing NaF were hardened and smooth. This study demonstrated that children's fluoride toothpaste with NaF contribute to the improvement of children's oral healthcare. **Improvements/Applications**: The children's fluoride toothpaste containing 0.243% NaF suggests surface remineralization and prevents early childhood cavities.

Keywords: Children's Toothpaste, Early Childhood Cavities, Fluoride, Primary Tooth, Surface Change

1. Introduction

Humans possess the unique characteristic of losing their primary teeth in childhood followed by the replacement with permanent teeth. The eruption of primary teeth begins at six to eight months of age, and is completed between 20–30 months of age[1]. Permanent teeth typically emerge around six years of age, and help make room for the eruption of permanent succedaneous teeth, and aid in normal jawbone development between six to 12 years of age[2]. If the primary teeth are healthy, the succedaneous teeth that subsequently erupt are also likely to be healthy. Therefore, meticulous oral care is necessary from the time of primary tooth eruption. Furthermore, since primary teeth possess a lower amount of mineral components, and differ in size and shape from permanent teeth, early childhood dental cavities develop very rapidly. Additionally, the development of childhood cavities may infect the dental pulps, as well as eventually destroy the entire crown[3]. Therefore, developing excellent habits for oral health care during childhood not only enhances oral health during youth, but also creates an important foundation for lifelong oral health management[4]. Maintenance of oral health until the loss of primary teeth also enables the appropriate function of teeth in terms of aesthetics and pronunciation[5]. Some studies have reported that the mineralization of teeth occurs for a year after primary teeth are lost, and that the appropriate application of fluoride can be used to protect against the development of an acidic environment[6]. The opinion that fluoride application aids in the prevention of early childhood cavities is widely accepted. The application of fluoride, combined with the crystal structure of enamel, creates a firm structure, and increases the density and hardness of the enamel surface[7]. The increased acid resistance in teeth is known to prevent dental cavities and enamel erosion, as well as to

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promote the remineralization of enamel[8]. Further, various types of fluoride application methods are frequently used.

Brushing is the most widely practiced method of personal oral hygiene management, and a proper brushing technique can effectively control dental plaque[9]. Many researchers recommend brushing as a basic method of effective oral hygiene management for infants as well, as it has been reported that proper brushing is highly effective for the prevention of childhood cavities[10-12]. Numerous methods for easy treatment application have been studied, and children's fluoride toothpaste is reported to be the most effective remineralization material. Using children's fluoride toothpaste is not only practical for managing the dental plaque, but also for cultivating good tooth brushing habits[13]. The toothpaste, along with the brush, reduces plaque and tartar buildup on the surface of the teeth, and helps prevent discoloration of surface enamel[14]. Additionally, the main components of the paste used to effectively clean the surface of teeth include bleach, detergent, bonding agents, and dehumidifying agents, and may also include other ingredients such as flavoring, a sweetening agent, preservatives, medicine, a coloring agent or a bleaching agent[15]. In particular, fluoride is the main substance that promotes remineralization; thus, the availability of fluoride in various applications makes the preventive approach for the purpose of enamel remineralization even more important[16]. Further, many studies have shown that tooth erosion due to acid exposure can be treated with fluoride, and that applying fluoride to tooth enamel can promote remineralization[17-19]. Study results have led to recent trends in early childhood cavity prevention involving the use of children's fluoride toothpaste. According to research regarding the effects of various types of fluoride, it has been reported that toothpaste containing sodium fluoride (NaF) is more effective for preventing cavities[20]. Therefore, children's NaF toothpaste not only prevents childhood cavities, but also encourages the remineralization of primary tooth enamel.

A review of previous studies indicated that[21] reported only the frequency of the use of children's toothpaste, but not results regarding changes to the surface of teeth. Since primary teeth play an important role during the period when primary teeth are replaced by permanent teeth, good oral health management through brushing might not only prevent early childhood cavities, but also help in the development of permanent teeth. In this study, after the application of children's toothpaste containing 0.243% NaF to primary teeth for four weeks, surface changes of teeth were examined to analyze the effect of NaF on enamel remineralization, as well as the ultimate contribution of NaF to the improvement of children's oral health care.

2. Materials and Methods

2.1 Preparation of Primary Tooth Enamel Specimens

The extracted primary teeth were selected no abnormalities or damage for use in the study. Using a soft-tissue cutting instrument (Minitom, Struers, and Copenhagen, Denmark), 60 flat enamel specimens (2 x 3 x 2 mm) were produced. The samples were divided into three groups, with 20 specimens per group.

2.2 Experimental Design

The treatments were divided into three groups (n = 20), and the components of the materials used in are shown in Table 1. Group 1 served as the control group, and included the primary tooth enamel specimens stored in artificial saliva that received no treatment. In Group 2, children's toothpaste without fluoride was applied to the teeth enamel three times a day for three min while the teeth were brushed in a circular motion. The teeth were then rinsed with sterile distilled water, and stored in artificial saliva to recreate oral hygiene conditions. In Group 3, children's fluoride toothpaste containing 0.243% NaF was applied to the surface of primary tooth, and the teeth were also rinsed with sterile distilled water and stored in artificial saliva, similar to Group 2. The artificial saliva in each group was replaced three times a day, and all processes were repeated for a total of four weeks. To measure the levels of primary tooth enamel remineralization as a result of fluorosis at one-week intervals surface changes were evaluated.

2.3 Scanning Electron Microscopy Analysis

To observe the changes in primary tooth enamel surfaces as a result of the application of the two different toothpastes, scanning electron microscopy (SEM; JSM-6300, JEOL, Japan) analysis was conducted. The tooth specimens were dried and coated with white gold, then examined using 2000X magnification and an acceleration voltage of 15 kV.

Table 1. Composition of experimental toothpastes used in this study

Material	Composition	Manufacturer
Child toothpaste (Colgate Children's 2 in 1 Toothpaste and Mouthwash)	Sodium Fluoride 0.243% Sorbitol, Water, Glycerin, Hydrated Silica, PEG 12, Sodium lauryl sulfate, Tetrasodium pyrophosphate, Cocamidopropyl betaine, Sodium saccharin, Aroma, Xanthan gum, Red 40	Colgate, USA
My First Colgate™	Propylene glycol, Glycerin, Hydrated silica, Sorbitol, Water, Poloxamer 407, Cellulose gum, Sucralose, Citric acid, Flavor	Colgate, USA

3. Results and Discussion

Previously, it was reported that recognizing the differences between various anatomical, systematic, pathological, and biochemical approaches is important in the oral care of primary teeth[22]. Consequently, dental care and hygiene have been deemed one of the most important health management issues during childhood[23]. This study compares and morphological changes on primary teeth surfaces following the application and brushing with children's toothpastes with and without fluoride.

Primary tooth enamel erosion by acid occurs very rapidly, while remineralization induced by saliva occurs very slowly. Thus, if sufficient remineralization does not occur after frequent exposure, damage to enamel, including childhood cavities can occur[24]. To prevent enamel erosion and promote remineralization, various methods involving fluoride are used. Many studies have reported various applications of fluoride for the prevention of dental cavities. Further, the use of fluoride reportedly reduces acid solubility, increases microhardness and, when applied to eroded enamels, provides anti-cavity and anticorrosion effects by promoting the enamel remineralization[25-26]. Among the many application methods, fluoride in toothpaste is not only commercially available in a variety of types, but is also reported to have consistent global effects[26]. Therefore, this study evaluated the effects of enamel surface remineralization through measurement and observation of surface changes following the application of fluoride toothpaste on primary teeth for four weeks, with the aim of preventing childhood cavities.

The result of the analyses of differences in the control group primary tooth surface enamel after four weeks, and the primary tooth surface enamel of the groups treated with children's toothpaste with and without fluoride is shown in Figure 1. Upon examination of the changes from one week to four weeks in the primary tooth surfaces treated with fluoridated toothpaste, results indicated strengthening of the surface beginning at three weeks. After four weeks, tooth surfaces treated with fluoridated toothpaste showed significant remineralization (Figure 2).

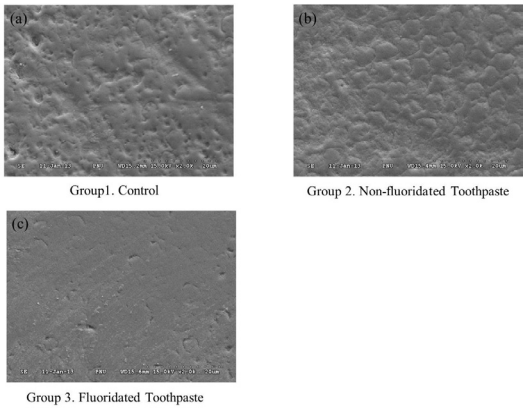

Figure 1. Primary tooth enamel treated with different toothpaste types after four weeks.

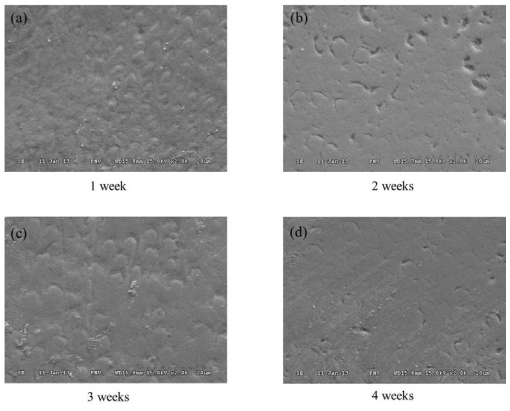

Figure 2. Changes in primary tooth enamel surfaces treated with toothpaste over four weeks.

In[27] confirmed that the application of mouthwash containing low concentrations of fluoride, along with the use of fluoride toothpaste, had a remineralization

effect on the enamel surface. Additionally[28], reported that toothpaste containing fluoride increased the remineralization effect.

The responsibility of ensuring toothpaste use in infants falls on the parents, and it has been reported that educating the parents and providing them with information regarding toothpaste contents are necessary to promote the selection of age-appropriate toothpaste[29]. Accordingly, parents play an important role in childhood oral care, and it is believed that the systematic education of parents in children's oral care is essential. Previously published literature on children's toothpaste only reported the investigation of the fluoride content of toothpastes, or reported fragmentary results regarding childhood oral care. However, in addition to the current research, collection of data on rapidly changing oral care products and their effects are necessary to establish an oral healthcare system suitable for the oral health requirements of children. Furthermore, development of toothpastes tailored specifically for children, through a follow-up study on the effects of various tooth surface shapes, is deemed necessary in order to provide diverse toothpaste options. Besides, development of children's toothpastes would allow options for choosing the toothpaste appropriate for the individual's oral conditions, in order to prevent early childhood cavities as well as promote long-term oral health.

In this study, treatment of primary teeth with toothpaste containing fluoride was revealed a smoothened surface. These results indicated that such treatment promotes surface remineralization, and thus prevents early childhood cavities. Therefore, we suggest the use of fluoridated toothpaste when brushing the teeth of infants, to preserve their oral hygiene.

4. Conclusion

The application of children's fluoride toothpaste containing 0.243% NaF to primary teeth resulted in an increase in the surface strength. The application of children's fluoride toothpaste promotes surface remineralization, and prevents early childhood cavities.

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