

Remineralization Potential of Three Tooth Pastes on Enamel Caries

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Abstract

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BACKGROUND: Different formulations of dentifrices exist in the market. Usually, single toothpaste is used by all family members including children. There is a big concern of fluoride ingestion with the toothpaste containing high fluoride content in children. Recently, new toothpaste (including toothpaste) with remineralization potential without fluoride content has been formulated.

AIM: There is an urgent need to compare remineralization potential of this new formulation with the existing dentifrices. Therefore, the present study has been undertaken to assess and compare the remineralization potential of three dentifrices with different compositions on artificially induced carious lesions in vitro by using scanning electron microscopy and polarised light microscopy.

MATERIALS AND METHODS: The present in vitro study was conducted on 21 healthy extracted primary central incisor teeth surfaces, which were divided into three groups and were treated by three different dentifrices. Artificial demineralization was followed by remineralization using dentifrice slurry as per the group distribution. All the samples were studied for remineralization by using scanning electron microscopy and polarised light microscopy. Data were analysed using SPSS version 11 software.

RESULTS: A significant difference was found between the remineralization potential of incident toothpaste and other toothpaste groups based on the analysis of polarised light microscopy and stereomicroscope. The remineralizing ability of incident toothpaste for artificial enamel lesions was found to be significantly higher than that of Colgate® and Crest toothpaste.

CONCLUSIONS: The limitations of this study include, being a short term study, low sample size and in vitro experiment. Incident toothpaste has exhibited a higher remineralizing potential as compared to fluoride based toothpaste in our study.

Introduction

Dental caries is a major oral health hazard in developing countries and is more common in childhood [1, 2]. Prevalence of dental caries is 41% in children within the age of 2-11 years [1, 2]. The process of demineralisation and remineralisation is steady and occurs simultaneously in the oral cavity, but a disturbance in this mechanism could lead to dental caries. This mechanism is directed by the degree of saturation of oral fluids with apatite minerals [3-6]. Remineralization of enamel surfaces is inhibiting in the case of primary caries by using topical fluoride. Fluoride ions promote the formation of fluorapatite in enamel in the presence of calcium and phosphate ions produced during enamel demineralization due to

organic acids of plaque bacteria [4-8]. Fluoride toothpaste act as cariostatic agent especially for children [6-8]. Different fluoride based toothpaste exist in markets, but recently a no fluoride toothpaste has also been introduced in the market like incident toothpaste, possessing desirable properties for remineralization. pH cycling systems assess caries lesion and mineral changes in dental hard tissues [6-9]. In vitro environment of pH-cycling models has been used to study dynamics of the dental decay [1, 2, 10-15].

The present in-vitro study was conducted to assess the effects of three different child formula dentifrices (Colgate® kids cavity protection toothpaste, USA; Crest, 500 ppm, NaF, Procter & Gamble, Germany and Incident toothpaste, Denmark) on remineralization of artificial caries in

primary teeth by using a pH cycling model.

Methods

This study was conducted on twenty-one extracted sound primary central incisor teeth. The sample was quantized into three groups such as (Group A, Group B and Group C). Group A was treated with Colgate® kids cavity protection toothpaste (USA), Group B was treated with Crest children's toothpaste Crest, 500 ppm, NaF, (Procter & Gamble, Germany) and Group C was treated with incident children's toothpaste (Denmark). A slurry of each toothpaste was prepared by 3:1 weight ratio of deionized water to toothpaste. Seventeen grammes of each toothpaste was transferred to three tubes containing 51 mL of deionized water and then mixed using a vibrator (Vortech, Korea). Demineralizing and remineralizing solutions were prepared. The demineralizing solution consisted of 0.05 M acetic acid, 2.2 Mm CaCl₂, 2.2 Mm NaH₂PO₄ and 1M KOH for adjusting the pH to 4.5. The remineralizing solution contained 1.5 mM CaCl₂, 0.15 M KCl and 0.9 mM NaH₂PO₄ and had a pH of 7. The artificial carious lesion was created. Debris was removed, and the teeth were visually examined for any lesions. Teeth were stored in the normal saline solution. The surfaces of specimens were coated with one layer of acid-resistant varnish (Max Factor, France) except for a 1x1 mm window on the buccal enamel surface; which continued intact. All specimens were subjected to pH cycling models for 20 days. Each specimen was immersed in the demineralizing solution (10 mL for each specimen) thrice a day for 4 hours and in the remineralizing solution (10 mL for each specimen) for 2 hrs in-between the de-mineralization cycles.

Table 1: Mean (SD) degree of demineralization as well as changes before and after treatment with different kinds of toothpaste (stereomicroscopic analysis)

Toothpaste	Depth of lesions		Changes in depth of lesions
	Before treatment	After treatment	
Colgate®	47.6 (6.2)	40.7 (6.8)	-6.9 (6.1)
Crest	50.3 (10.3)	44.7 (10.6)	-6.9 (5.6)
Incident	45.6 (10.4)	36.4 (10.2)	-8.5 (4.5)

Each specimen was immersed in the toothpaste solution (5 mL for each specimen) for two minutes before the onset of the first demineralization cycle. The same procedure was repeated before and after the second demineralization cycle also. Teeth were stored in the remineralizing solution overnight at normal temperature. Specimens were rinsed with deionized water for two minutes to stop the cross reaction of solutions after application of toothpaste. Fresh toothpaste solution was used for each cycle of remineralization and demineralization. The pH of solutions was measured daily by a pH meter. Separate plates were used for each group of specimens in all phases of the experiment. After completion of 20-days pH cycle and post-treatment assessments, the acid-resistant varnish was

completely removed using acetone. Images of all teeth sections were obtained before and after exposure to treatment regimens under a polarised light microscope and a stereomicroscope. Data were analysed by using SPSS version 11 software, and descriptive statistics were applied to the three different groups for both the phases of before and after treatment.

Results

The degree of demineralization before and after treatment with different kinds of toothpaste as well as changes in the degree of demineralization was observed under a polarised light microscope and a stereomicroscope as depicted in Table 1 and 2.

Table 2: Mean (SD) degree of demineralization as well as changes before and after treatment with different kinds of toothpaste (polarised light microscopic analysis)

Toothpaste	Depth of lesions		Changes in depth of lesions
	Before treatment	After treatment	
Colgate®	98.6(12.3)	75.7(13.2)	-22.6 (14.8)
Crest	103.4(10.3)	78.2(15.2)	-24.5 (10.8)
Incident	108.3(13.3)	51.4(13.6)	-48.9 (12.6)

A significant difference was found among Incident toothpaste, and other toothpaste groups based on polarised light microscopic and stereomicroscopic analysis ($P = 0.005$) (Table 1 and 2). The remineralizing ability of Incident toothpaste for artificial enamel lesions was significantly greater than that of Colgate® and Crest toothpaste.

Discussion

The present study was conducted to compare the remineralization effects of three different child formula toothpaste (Colgate kid, Crest children toothpaste & Incident toothpaste) on of artificial enamel lesions in primary teeth by using a pH cycling model. The degree of demineralization before and after treatment and its changes were analysed using a stereomicroscope and a polarised light microscope. In the present study, the polarised light microscope was used to measure the depth of lesions, and their expansion as polarised light microscope method appears to be more reliable in the measurement of the depth of lesions and their expansion as compared to stereomicroscopic assessments as supported by a previous study [15].

The pH cycling model has been used in the present study as it is a good tool for assessment of the preventive effect of different materials of

demineralization or and remineralization process of artificial caries [10]. Fresh solutions were used to avoid the risk of reaching the saturation threshold as well as measuring pH of solutions daily.

Assessment of cariostatic effects of agents by using pH cycling model has different limitations also such as it incompletely simulates the oral conditions such as nutritional habits, hygienic measures, fluoride sources consumed, and saliva composition, etc. but it is still most commonly used method in dentistry and clinical setup. The enamel of primary tooth contains higher organic content as compared to the permanent tooth, which makes the primary tooth enamel more vulnerable to caries than the permanent enamel [4-7, 8-11].

Results of the present study indicate a significant difference in the carious lesion observed in polarised light microscopic and stereomicroscopic examination in Incident toothpaste group as compared to other groups. It might be due to Cur TM i.e. which act as remineralization enhancing agent which leads to a reduction in depth of caries. In previously conducted studies, Fluoride toothpaste with 500ppm was observed to be more effective than non-fluoride toothpaste for prevention of demineralization in primary tooth enamel [4, 12, 13]. In the present study, incident toothpaste does not contain fluoride, but it consists of remineralization enhancing agent which is more effective than the fluoride toothpaste. Colgate® and Crest's toothpaste have higher cariostatic efficacy as compared to non-fluoride toothpaste as reported in a previous study [2]. It might be due to remineralization and increases fluoride uptake action of fluoride [15-18].

The present study has its limitations in the form of being a short-term study, low sample size and in vitro experiment. The study reflects that incident toothpaste exhibited higher remineralizing potential as compared to fluoride based toothpaste. Further human clinical trials could be conducted to study the mineralisation action of incident toothpaste.

In conclusion, within the limitations of this study, incident toothpaste has exhibited a higher remineralizing potential as compared to fluoride based toothpaste.

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