EVALUATION OF THE REMINERALIZING EFFECT OF FLUORIDATED TOOTHPASTE WITH SODIUM HEXAMETAPHOSPHATE ON DEMINERALIZED PRIMARY TEETH ENAMEL

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ABSTRACT

Background: A primary aim of pediatric dentists is to repair the early demineralized enamel without intervention through remineralization. Sodium hexametaphosphate (SHMP) is a remineralizing material that has been reported to have promising results for caries management.

Aim of the study: Evaluation of the remineralization potential of fluoridated toothpaste with SHMP on demineralized enamel of primary teeth.

Materials and Methods: Fifty six freshly extracted anterior deciduous teeth were collected and divided into four groups regarding the concentrations of SHMP added to 400 ppm F containing tooth paste. Three groups contained (0.25%, 0.5%, 1%) respectively and a control group without SHMP. Specimens were treated with the tooth pastes and exposed to pH cycling for 5 days then a remineralizing solution for additional 2 days. Specimens were evaluated using Digital Radiographic Density Analysis at baseline, after demineralization and after remineralization.

Results: Teeth treated with SHMP showed marked remineralization effect than those treated with fluoride alone. Increasing the concentration of SHMP from 0.25, 0.5 to 1%, associated with increased the remineralizing effect.

Conclusion: SHMP has a superior remineralizing effect over fluoride alone. 1% SHMP concentration added to 400F ppm toothpaste provided the best results.

KEY WORDS: Enamel remineralization, Sodium Hexametaphosphate, Toothpaste, Fluoride, Primary teeth.

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INTRODUCTION

Despite the efforts of preventive dentistry, dental caries still has high prevalence. Remineralization aims to repair the early demineralized enamel lesions without intervention to prevent caries progression and cavitation. Remineralization redeposits minerals lost by enamel. It occurs by deposition of calcium and phosphate on tooth surface therefore, preventing early enamel lesions.

Fluoride can promote remineralization and inhibit demineralization of enamel. However, increasing concerns regarding safety of products with high fluoride concentration have evolved.

SHMP is a remineralizing material that has reported promising results for caries management. In addition, it seems that remineralizing agents exert synergic effects when used together with SHMP.

The current study was conducted to evaluate the effect of remineralization potential of fluoridated hexametaphosphate toothpaste on primary demineralized tooth enamel using Direct Digital Radiographic Density Analysis.

MATERIALS AND METHODS

Teeth collection

Fifty six freshly extracted anterior deciduous teeth were collected, and stored in physiologic saline for maximum one month. Selected teeth were sound; free of caries, restoration, cracks, white spots or enamel defects.

Teeth preparation

Teeth were manually scaled, cleaned by soft brush with non-fluoridated toothpaste, washed and stored in physiologic saline in closed container. A piece of adhesive tape (3 x 3 mm) was put on the center of labial surfaces, and then nail polish was applied on the surface to standardize the area of treatment and evaluation.

Grouping

Thereafter, teeth were randomly allocated in equal 4 groups. Group (1) with no SHMP, group (2) with 0.25 % SHMP, group (3) with 0.5 % SHMP and group (4) with 1 % SHMP.

The concentration of SHMP was adjusted by adding 0.25gm, 0.5gm and 1gm to a 100ml of 400ppm of the fluoridated toothpaste to be ready for brushing.

Demineralization

Based on da Camara et al.(2016), Sub-surface artificial caries was created on enamel specimens by placing them solely for 72 hour at 37°C in 7.0 ml of a demineralizing solution (2.2 mM CaCl₂, 2.2 mM NaH₂PO₄, and 50 Mm acetic acid, adjusted pH of 4.7 with 1M KOH).

Samples were exposed to pH cycles for 5 days, each cycle involved six hours of demineralization (two hours each, three times daily), with eight hours of remineralization in between(four hours each, twice daily). A one-minute treatment (by brushing the teeth with the toothpaste) was given before the remineralization cycle three times daily. Then, all the samples were placed in remineralizing solution overnight at 37°C in an incubator for 10 hours. Finally, Samples were dipped for 2 additional days in a remineralization solution ( 2.00 g/L methyl p-hydroxybenzoate, 10.0 g /L sodium carboxymethyl cellulose, 8.38 mmol/L KCl, 0.29 mmol/L MgCl₂.6H₂O, 1.13 mmol/L CaCl₂.2H₂O, 4.62 mmol/L KH₂PO₄, 2.40 mmol/L K₂HPO₄; and adjusted pH was 7.0 using KOH) to simulate saliva.

Samples analysis was done using Direct Digital Radiographic Density Analysis by a computer program calculated automatically mean gray level values using direct digital radiographic imaging system (Digora unit Orion Ccpp. Sordex medical systems, Helsinki, Finlan). All the prepared specimens were digitally radiographed before demineralization, after demineralization and after treatment. Treatment effect was manifested radiographically as a change in pixel gray scale values (radio density) from their initial records.
The data were collected and the mean and standard deviation of grey shade values were calculated for each group in each test. Kolmogorov-Smirnov and Shapiro-Wilk tests explored the normality of data showing parametric distribution.

One-way ANOVA followed by Tukey post-hoc test was used to compare between more than two groups in non-related samples while repeated measure ANOVA was used to compare between more than two groups in related samples. Two groups in related samples were compared using paired sample t-test and the significance level was set at P ≤ 0.05. Statistical analysis was performed with IBM® SPSS® Statistics Version 20 for Windows.

RESULTS

In each tested group, there was a statistically significant difference before demineralization, after demineralization and after remineralization where (p<0.001).

Regarding relation between groups, No statistically significant difference (p=1) was detected before and after demineralization.

However, after remineralization, it was found that the mean grey values increased due to the increase in the mineral content, with the increase of SHMP concentration and there was a statistically significant difference between the tested groups where (p<0.001). Figures (1, 2)

DISCUSSION

Remineralization constitutes an effective method for minimally invasive dentistry that redeposits minerals lost from enamel preventing caries progression. While fluoride gains much popularity in remineralization, a number of new remineralization agents have been investigated and commercialized to promote deeper remineralization of early demineralized enamel to facilitate caries control (10).

Fluoridated dentifrices are suggested to be the cornerstone for caries suppression in children. Normally, fluoridated dentifrices contain 1000 ppm fluoride (11), however, due to safety considerations; lower fluoride content tooth pastes have been suggested for children (12).

SHMP is one of the remineralizing materials that were introduced in 2000 as an effective anti-tartar component in toothpastes (13).

Since the applications and concentrations of remineralizing agents differ from child to adult and that remineralizing agents exert synergic effects when used together (11), this study was performed to evaluate the remineralization effect of fluoridated toothpaste with SHMP on enamel of primary teeth and to find the best concentration.

This study was designed as in vitro study on deciduous teeth using pH cycling model that involved alternating the application of demineralization
and remineralization solutions at constant time intervals in order to simulate pH cycles in the oral environment (14).

Specimens were evaluated using Digital Radiographic Density Analysis. The changes from de-mineralization and remineralization can be detected from density value (15). Measuring the average gray level values was sensitive enough to detect small changes in the enamel surface (16).

The data gathered from this study was consistent with da Camara et al. (2016), who added SHMP to 1100-ppm F toothpaste and found marked remineralization of the demineralized enamel. Moreover, when the concentration increased from 0.25, 0.5 and 1 % of SHMP the remineralization power increased (7).

However, higher concentrations above 1% SHMP were not tested in the current study since these concentrations were detrimental, as they could interfere with absorption of fluoride into the enamel, larger percent of SHMP can sequester calcium ions from hydroxyapatite (7).

CONCLUSION

1) Adding SHMP to a 400 ppm fluoride tooth paste promoted the remineralizing potential over fluoride alone.

2) The best concentration for 400 F ppm toothpaste is 1% SHMP.

REFERENCES


