

Fluoride Varnish Effect on Dental Erosion Immersed with Carbonated Beverages

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Abstract

Dental erosion is still occurring worldwide due to exposure of the enamel to non-bacterial acids. Dental erosion may cause mineral loss occurs from the surface of the tooth (demineralization). Demineralization of dental enamel will occur when oral environmental pH reaches the critical threshold 5.5. Carbonic acid drinks is one of acid source which widely consumed. Fluoride has an important role in remineralization process. Topical fluoride is one of treatment choices to strengthen enamel and dentin. This material contains 5% or 22.600 ppm of sodium fluoride.

To analyze the effectiveness of fluoride varnish to prevent dental erosion caused by carbonic acid drinks.

21 bovine teeth divided into 3 groups. Group I (control) which submerged on artificial saliva and aquadest. Group II (Treatment I) with submerged in erosive cycling. Group III (Treatment II) treated with fluoride varnish application and submerged in erosive cycling. The sections of the teeth were examined under Scanning Electron Microscop-Energy Dispersive X-Ray (SEM-EDX). The data were analyzed using the Kruskal-Wallis Test, Tukey HSD, and Pearson Correlation test.

Group I showed the average of erosion depth is 12,0445µm and fluoride composition is 2,4314%, Group II showed the biggest average of erosion depth 100,15 µm and fluoride composition 1,6043%, and Group III showed the average erosion depth is 26,5886 µm and fluoride composition is 4,3471%.

There is a correlation between the depth of dental erosion and fluoride content. The depth of dental erosion caused by carbonic acid decreased after fluoride varnish application.

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Introduction

Fluoride plays an important role in accelerating remineralization of caries lesions on the enamel.¹ Enamel is the outermost and most hard layer of the tooth.² Enamel may undergo remineralization and demineralization processes.³ Remineralization is repair process of tooth mineral, while demineralization is process of mineral loss from the tooth surface. The ratio between the process of remineralization and demineralization can determine the hardness and strength of the teeth.⁴

Fluoride has an important role to

accelerate remineralization process to prevent caries. Enamel demineralization could occur when the enamel is in an acidic environment (pH below 5.5).⁵ Demineralization process lead to low pH and increase the hydrogen ions concentration. High hydrogen ion content will damage the hydroxyapatite in tooth enamel.⁶ The acidic environment in the oral cavity may occur when a certain group of bacteria attaches and metabolizes carbohydrates form tooth surface.⁷ If this process continues, it will lead to caries lesions on enamel or dentin.⁸ Demineralization of teeth can be reduced or inhibited by prevent the acid diffusion on the tooth surface. The acid diffusion can be stopped by reducing acid contact with the tooth surface.⁷

Fluoride can provide stability on the enamel surface. Calcium and phosphate from saliva combined with fluoride and enters beneath the surface of the lesion, then form a new layer on remaining residual enamel crystals. The resulting stability makes the enamel surface

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more resistant to the acid.⁹

Fluoride might also play a role to decrease enamel demineralization resulting from acidic conditions without bacteria fermentation that called dental erosion.¹⁰ Tooth erosion is a process of chronic tooth mineral loss caused by non-bacterial acid, derived from food or saliva.^{11,12,13} The process of dental erosion begins when calcium ions released from tooth enamel. The release of calcium ions is affected by the level of acidity, the lower the acidity of the tooth, the higher the rate of release of calcium ions from the tooth enamel. The release of calcium ions will cause the loss of enamel prism resulted in enamel porosity that caused the enamel surface hardness decrease. Loss of enamel mineral that reach dentine will cause pain.⁵

Dental erosions can be caused by acids derived from both extrinsic and intrinsic factors.² Acidic foods and beverages are the most common causes of extrinsic tooth erosion.^{1,13} One of the most acidic beverages is carbonated soft drinks. Carbonated soft drinks generally have a low pH below 5.5. The carbonated soft drink is much preferred because it is delicious and easy to drink. Cola is one type of carbonated soft drink favored by consumers of soft drinks in Indonesia. Research shows that 72% of the most popular carbonated beverages are Cola.¹⁴ Coca-cola carbonated beverages have a low pH of 2.38.¹³

In general, fluoride is applied in topical form, one of it is fluoride varnish.¹⁵ Fluoride varnish is an ingredient attached or applied to the tooth surface, yellow, semi-liquid, containing fluoride resin and alcohol that can dry rapidly. This material contains 22,600 ppm or 5% sodium fluoride. It is quite easy to apply because it is only applied on tooth enamel. The purpose of fluoride varnish applications is to keep fluoride in contact with teeth for a long time.¹⁶

In a previous study, the use of NaF varnishes (duraphat-colgate and duofluorid) on cow teeth immersed in soft drinks (coca-cola) can protect tooth surface from erosion until the 4th day of the erosion cycle.¹⁸

In a previous study, Silver Diamine Fluoride (SDF) has been used as a cariostatic agent. SDF helps in deposition of silver phosphate to restore mineral content, resulting in rehardening of tooth structure. SDF also increases the microhardness of carious dentin, reduces

loss of calcium and phosphate ions and lessens collagen damage. SDF releases fluoride and it helps the deposition of silver phosphate to restore the mineral content, resulting in rehardening of the tooth structure. SDF has been shown to remineralize carious dentin and increase its microhardness.¹⁹

The purpose of this study was to analyze the effect of fluoride varnish application to depth of tooth erosion immersed with acidic carbonic beverage.

Materials and methods

Preparation

This laboratory research is a post-test only controls group design experiment. Cow incisors (n = 21) is immersed in 2.5% NaOCl solution (OneMed, Indonesia). The teeth cleaned with distilled water (Water One, OneMed, Indonesia) and immersed in the saline solution (PT Widata Bakti, Indonesia). The tooth then cut to the cervical part using a carborundum disc (Intensive Dental Diamond, Switzerland). The cervical and palatal parts of the tooth are coated with nail polish.

Erosive Cycling Process

The samples were immersed in carbonated beverages (Coca-Cola, Bekasi, West Java, Indonesia) at room temperature for 10 minutes (30 ml per tooth). Then the tooth was washed with water (Water One, OneMed, Indonesia) and dried. Furthermore, the sample was immersed in an artificial saliva containing 1.5 mmol/L $\text{Ca}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$, 0.9 mmol / L $\text{NaH}_2\text{PO}_4 \cdot 2\text{H}_2\text{O}$, 150 mmol/L KCl, 0.1 mol/L Tris Buffer, 0,03 ppmF (Badan Besar Laboratorium Kesehatan, Surabaya, Indonesia) for 50 minutes (15 ml per tooth). Each day, samples were exposed to 6 cycles with a total of 6 hours immersed in coca-cola and 18 hours in artificial saliva.

Procedure

Teeth were grouped randomly into 3 groups; each group consisted of 7 teeth. Group I (control group), the teeth were immersed in artificial aquades and saliva, Group II (Treatment I) was treated with erosive cycling without fluoride varnish coating (Clinpro White Varnish, 3M ESPE.) Group III (Treatment III) was treated with erosive cycling with previously fluoride varnish teeth. Fluoride varnish was applied in one layer on horizontal direction, then wait for 6

hours until setting. After the treatment, the tooth cut in a longitudinal direction using a carborundum disc. The porosity test and mineral content were tested using SEM-EDX (FEI, Inspect-S50).

Data Analysis

The data obtained from the results of the study with the normality test using Kolmogorov Smirnov test while for homogeneity tested using Levene Tests. A comparative test was performed by Kruskal-Wallis test while the comparative test between Tukey HSD groups. The correlation test about the depth of erosion and fluoride content was performed using Pearson Correlation test ($p < 0.05$).

Results

The results of the erosion depth test can be seen in Figure 1. The group without fluoride varnish applied has the deepest erosion when compared to group I and group III. The average value of erosion depth and fluoride content in each group can be seen in Table 1.

The Kolmogorov Smirnov test result on erosion depth data distribute normally ($P > 0,05$) but homogeneity test using Levene test showed heterogeneous data ($P < 0,05$). Different erosion depth tests using Kruskal Wallis test showed differences in the study group ($P < 0.05$). Different test between groups using Tukey HSD showed $P < 0.05$. The Kolmogorov Smirnov test for fluoride content showed that the data distribute normally ($P > 0,05$) while Levene test showed heterogeneous data ($P < 0,05$). The Kruskal Wallis test showed a difference in the study group ($P < 0.05$). Different test between groups using Tukey HSD showed $P < 0.05$. Pearson correlation test results showed the greater the depth of erosion, the smaller the content of fluoride in the teeth ($P < 0.05$).

Discussion

In this research, we measured the depth of the erosion lesion to determine the effect of fluoride varnish which is applied to the teeth after soaking in the carbonated soft drink. Fluoride varnish has the potential for remineralization to inhibit erosion due to the loss of tooth mineral.

The research sample used in this research is cow teeth. This has done because bovine teeth are easy to get and more available.

Bovine teeth have a composition similar to human teeth. Bovine teeth have a larger surface area compared to human teeth so it is easier to manipulate when the research is done.¹⁸ Erosive cycling in this study was made to create similar conditions in the oral cavity. Erosive cycling was conducted using several solutions with different pH. Different pH was made following the demineralization and remineralization in the oral cavity.²⁰

The carbonated soft drink has a low pH, from 2.5 to 4.2 which can cause demineralization of tooth enamel. The lower the pH of the carbonated soft drink, the greater the solubility of tooth enamel so that it is potentially more erosive than drinks with a higher pH.²¹

The application of fluoride varnish causes the exchange of OH-ions and F-ions that form fluoroapatite. Fluoroapatite has a more acid-resistant property. Fluoride release from fluoride varnish can inhibit bacterial growth and increase remineralization. Fluoride can absorb the surface of the crystal and attract calcium ions and phosphate ions resulted in the formation of new minerals or layers. Fluoride ions released from fluoride varnish act as a component that increase the process of remineralization.^{22,23}

Remineralization was also affected by the exchange of calcium ions (Ca^{2+}) and phosphates (PO_4^{3-}). This exchange may occur when the adhesion of fluoride varnish to the tooth surface. The application of fluoride varnish increased calcium and phosphate that play an important role to enhance the remineralization. Calcium and phosphate ions will inhibit the hydroxyapatite decomposition process and rebuild or redevelop of dissolved hydroxyapatite crystals. The acid-induced micro porosity in this study using coca-cola resulted in tooth enamel having high surface tension energy. The high surface stress allowed calcium from the application of fluoride varnish to enter into the micro porosity. Fluoride varnish application on the enamel microporosity will replace calcium and phosphate ions dissolved by acid conditions.²³

Conclusions

There was a correlation between the depth of dental erosion and fluoride content. The depth of dental erosion caused by carbonic acid decreased after fluoride varnish application.

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Declaration of Interest

The authors report no conflict of interest.

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