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THE EFFECTIVENESS OF COMPOMER AND GIC AGAINST PREVENTION IN ENAMEL DEMINERALIZATION.

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ABSTRACT

Background: Several studies showed that fluoride interferes in the dynamics involved in the development of caries and could present an antimicrobial effect or provide demineralization inhibition or dental remineralization. The development of fluoride-releasing materials can contribute to a preventive of demineralization. GIC and Compomer are restorative materials containing fluoride which can prevent demineralization. **Purpose:** To analyze the effectiveness of Compomer and GIC against prevention in enamel demineralization. **Method:** The cavities were made on 18 bovine teeth which grouped into 3 groups, each group consisting of 6 bovine teeth. After the restorative procedures, the teeth were submitted to demineralization and remineralization cycling during 14 days. The sections of the teeth were examined under scanning electron microscope after undergoing pH cycling. The data were analyzed using the Kruskal-Wallis and Tukey Test ($p < 0.05$). **Results:** GIC group showed the lowest lesion depth of demineralization (10.9883 ± 0.74333) followed by Compomer group (25.4183 ± 3.44268) and Control group (88.9783 ± 3.02495). **Conclusion:** GIC restorative materials have a better enamel demineralization prevention effect than Compomer.

Keywords: compomer, demineralization, fluoride, GIC, remineralization

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INTRODUCTION

Several studies have shown that fluoride can prevent caries development since it has anti-bacterial effects. Fluoride is also known to be able to prevent demineralization process as well as stimulate the remineralization process. Another research on the development of fluoride-containing restorative materials also revealed that fluoride may have a role in the preventing caries formation. Similarly, Dionysopoulos, said that the fluoride ion released by a restorative material reduced demineralization around restorations.¹

The development of dental restorative materials actually has been rapidly growing as the advancement of technology today, one of which is Glass-ionomers (GIs). GIs were first introduced in

1972 by Wilson and Kent. Their chemical adhesive potential and fluoride releasing properties have led to their widespread use as luting materials, cavity liners and bases, as well as restorative materials. In addition, GIs also has mechanical properties, such as compressive strength, tensile strength, hardness, and low fracture toughness.² Furthermore, other restorative materials incorporate conventional composite resins and GIC (Glass Ionomer Cement).

The material is then called as Polyacid-Modified Composite Resins (PMCR) or well-known as compomer. Besides, this restorative material is also known to release much lower fluoride ions than conventional GIC.³

Fluoride is a natural element that strengthens teeth and prevents their deterioration. Experts believe

that the best way to prevent cavities is use of fluoride from multiple sources.⁴ Fluoride acts by inhibiting mineral loss at the crystal surfaces and by enhancing the rebuilding or remineralization of calcium and phosphate in a form more resistant to subsequent acid attack. Fluoride can be firmly bound when it is incorporated in the crystalline lattice of hydroxyapatite or loosely bound when it is adsorbed to apatite forming calcium fluoride deposits. Calcium fluoride is formed during treatments with high concentration fluoride solutions. It can act as a fluid reservoir on the tooth surface and release fluoride ions at low pH. This fluoride ion along with calcium and phosphate diffuses into the lesion and precipitates as fluoridehydroxyapatite.⁵

Dental caries is a widely prevalent disease problem globally. All of dental practitioners knows about fluoride and its ability to prevent dental caries. GIC and Compomer are the fluoride-releasing filling materials which are used widely in dentistry. Thus, this research aimed to investigate differences in the effects of GIC and compomer in preventing demineralization on enamel. This research also aimed to analyze the effectiveness of fluoride contained in compomer as a restorative material compared with GIC in preventing enamel demineralization.

MATERIAL AND METHODS

This research used 18 cow's incisors extracted after the animals were slaughtered. After the extraction, the incisors were cleaned from the periodontal tissue, while the crown and root parts were separated by carborundum disc. Next, all the dental crowns were immediately immersed in saline solution. Those samples then were divided into three groups, namely control group, compomer group, and GIC group. Each of the groups consisted of six teeth. The matrix of each tooth was prepared using Copyplast material together with clear acrylic and type IV gypsum with pressure molding technique.

Afterwards, cavity was prepared in the labial area of those teeth with a diameter of 4 mm and a depth of 2 mm using the diamond wheel bur. All the teeth then were cleaned and dried, then all those tooth samples were ready to be cured. In the control group, all those samples were left untreated. In the compomer group, etching and bonding were applied on all of the samples. The cavity of those samples was subsequently filled using compomer (Dyract Flow, Dentsply) restorative material. Facial matrixes which were used for material adaptation on facial then were set on them, and given a load of 1 kilogram as well as light curing for 20 seconds. Meanwhile, in the GIC group, dentin conditioner was applied on all of the samples. The GIC capsules (Fuji IX Extra Capsules, GC) then were mixed using a mixer for 10

seconds before it was applied into the cavity of those samples by using an applicator. Matrixes were subsequently set on them, given 1 kilogram load, and left for 5 minutes until the GIC material hardened. Varnish then was applied to the tooth surfaces that had been smeared with GIC material. After the filling procedure was completed, the entire surface of the tooth samples was coated with nail polish, except the edge of the restoration with a distance of 2 mm, then allowed to dry.

pH cycling was performed in all the samples for 14 days.⁶ All the samples then were immersed in a demineralization solution with a pH of 4.3 and a remineralization solution of pH 7 alternately each day. Afterwards, each was put in a separate container and incubated at 37° C. Each cycle, or each sample, then was immersed in 30 ml of demineralization solution (composition: Calcium 2.0 mmol/L, Phosphate 2.0 mmol/L, Acetic acid 75.0 mmol/L; adjusted to appropriate pH with 50% NaOH after all ingredients were dissolved completely) for 6 hours, rinsed with 30 ml of distilled water, soaked again in 30 ml of remineralization solution (composition: Calcium 1.5 mmol/L, Phosphate 0.9 mmol/L, KCl 130.0 mmol/L, Sodium cacodylate 20.0 mmol/L; adjusted to appropriate pH with 50% NaOH after all ingredients were dissolved completely for 18 hours. The demineralization and remineralization solutions of each sample were changed daily.

After the pH cycling treatment was completed, all the teeth were cut through the restoration in the longitudinal direction using a low speed hand piece and carborundum disc. The demineralization lesions formed around the restorative materials of each group then were examined using Scanning Electron Microscopy (SEM). The depth of demineralization lesions was determined based on the presence of thin and irregular enamel rods with unclear boundaries as well as the wide picture of the inter-rods zone. The depth of demineralization lesions then was measured in micro meters (μm) and recorded. After it was measured on three different locations, the mean score of the results then were calculated.

Subsequently, the data obtained were tested using Kolmogorov-Smirnov test to analyze the distribution of the data in each group, then Levene's test was conducted to find out the homogeneity of the data variance in each group. Afterward, to know differences in the depth of demineralized lesions between groups, Kruskal Wallis test was carried out.

RESULTS

After compomer restorative materials were compared with GIC related to their ability to prevent enamel demineralization, there were differences in

the depth of demineralized lesions. The control group was known to have the largest demineralized lesion depth on the enamel surfaces compared to the compomer and GIC groups. Meanwhile, the GIC group had the smallest demineralized lesion depth on the enamel surfaces compared to the compomer group as depicted in Figure 1. Meanwhile, the mean of the depth of demineralized lesions in each group was represented in Table 1.

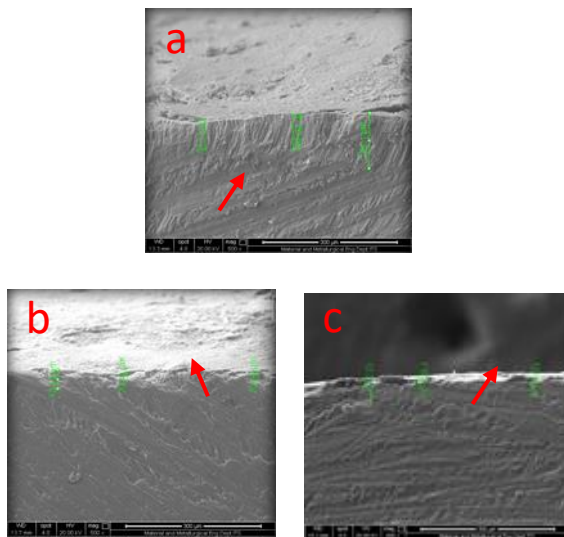


Figure 1. The depths of demineralized lesions on enamel in each group (SEM at 500x magnification), Red arrow pointed to the demineralized lesion depth in the control group (a), the compomer group (b), and the GIC group (c)

Moreover, the result of the Kolmogorov Smirnov test found that the data of the demineralized lesion depths in all groups were normally distributed ($p > 0.05$). Results of the Levene's test indicated that the data of the demineralized lesion depths in all three groups had no homogeneous variance ($p < 0.05$). Kruskal-Wallis test then was conducted to reveal the difference in the demineralized lesion depths among all three groups, and showed that there was a significant difference in the demineralized lesion depths among all three groups ($p < 0.05$).

Table 1. The mean score and standard deviation of demineralized lesion depth

Groups	N (The Number of Samples)	X (Mean Score of Demineralized Lesion Depth, μm)	SD
Control	6	88.97	3.02
Compomer	6	25.41	3.44
GIC	6	10.98	0.74

Tukey HSD test was performed to know differences in the demineralized lesion depths between the control group, the compomer group, and the GIC group. Result of the Tukey HSD test revealed that there were significant differences between the control group and the compomer group, between the control group and the GIC group, and between the compomer group and the GIC ($p < 0.05$) as illustrated in Table 2.

Table 2. The results of the Tukey HSD test on differences in the demineralized lesion depths between the control group, the compomer group, and the GIC group

Groups	Control	Compomer	GIC
Control		0.000*	0.000*
Compomer	0.000*		0.000*
GIC	0.000*	0.000*	

DISCUSSION

Results of the Tukey HSD showed that there was a significant difference in demineralized lesion depth between the control group, the compomer group, and the GIC group ($p < 0.05$). The GIC group had the smallest mean depth of demineralized lesions compared with the control and compomer groups. This suggests that GIC can prevent enamel demineralization better than compomers since GIC can release more fluoride than compomers.

GIC is water-based cement that solidifies through an acid/base reaction between liquid polyalkenoic acid, such as polyacrylic acid, and a glass component of fluoroaluminosilicate. Thus, the release of fluoride will increase due to the dissolution of glass particles in large quantities of cement and dissolved fluoride diffusing through a porous cement matrix. Next, fluoride joins the adjacent tooth structure, forming fluorapatite.⁷ Fluorapatite then will form more on hard tissue straps using GIC restorative materials so that the tooth structure becomes stronger and more resistant to exposure to oral acid.

The in vitro investigation showed that GIC (16.96 ppm) had a greater fluoride release than Compomer (2.11 ppm) since day one. Besides, the fluoride releasing ability may also be affected by material porosity; it means that more porosity can trigger fluoride to diffuse easily towards the surface.^{8,9} GIC is known to have a higher porosity level than compomer materials since GIC does not contain resin, while compomers contain resin, resulting in the possibility of porosity shrink. Therefore, the greater porosity of GICs can trigger fluoride ions to easily diffuse and release more than compomers. This is very advantageous and can facilitate better fluorapatite formation, especially in this research that using cow's teeth as samples since

the cow's teeth have a higher porosity than human teeth. Consequently, fluoride will more easily and more quickly diffuse into the structure of the dental tissue so that fluorapatite formation will be better. Besides, these conditions also can lead to the smaller demineralized lesion depth in enamels using GIC restorative materials than in those using compomer restorative materials. As a result, in this research, there was a significant difference in the demineralized lesion depth between GIC and Compomer restorative materials.

Moreover, the larger depth of demineralized lesions in the compomer group in this research may also be due to setting reaction in the compomers. After the materials are set, the fluoride ions in the compomers will be encapsulated by the HEMA resin matrix, resulting in smaller and slower fluoride-ion releasing rate into the humid environment than in GIC.¹⁰ The addition of the resin monomer composition even can lead to significantly reduced fluoride release.¹¹ Furthermore, fluoride released from GIC can also inhibit caries development because fluoride has antimicrobial effect, induced the remineralization and inhibited demineralization. Fluorides inhibit the growth of plaque bacteria by blocking enolase enzymes during glycolysis, inhibit demineralization when dissolved in saliva, stimulate remineralization by forming fluorapatite.¹²

In addition to fluoride levels affecting the occurrence of remineralization, the exchange of calcium (Ca^{2+}) and phosphate (PO_4^{3-}) ions also affects the remineralization at the time of GIC adhesion to the tooth structure. In the tooth structure, the addition of calcium and phosphate then play an important role in improving the process of remineralization. Nevertheless, the release of fluoride ions from GIC is considered as a complex process. Thus, the amount of fluoride ions released depends on various factors. Intrinsic factors that may affect the release of fluoride ions involve the formulation, solubility or porosity of the material. Therefore, the lower the pH is, the higher the fluoride ions will be released. Besides, the higher the temperature of environment is, the greater the fluoride ions will be released. Other factors, such as improper powder to liquidity ratio, improper mixing, and improper polymerization also affect the release of fluoride ions.¹³ It can be concluded that GIC restorative material can prevent enamel demineralization better than compomer.

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