Effect of Different Topical Fluoride on the Surface Roughness of Glass Ionomer Cement

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Abstract

**Objective:** To evaluate the effect of acidulated phosphate fluoride (APF) gel and sodium fluoride (NaF) gel on the surface roughness of glass ionomer cements.

**Methods:** Twenty disc-shaped samples were fabricated from glass ionomer cement (Fuji II, GC Gold Label, Japan) and divided into two test groups that is group I for acidulated phosphate fluoride (APF) gel application and group II for sodium fluoride (NaF) gel application. After 24 hours, the surface roughness (Ra) was determined using a profilometer (MarSurf M300, Germany). Samples surface were applied by topical fluoride gel according test group for 4 minutes. After the treatment, the surface roughness (Ra) was determined using a profilometer. T test was used to evaluate surface roughness measurement and the differences in surface roughness values between test groups.

**Results:** Acidulated phosphate fluoride gel group showed the highest surface roughness than sodium fluoride group. There were significant differences between test groups ($p = 0.00$).

**Conclusion:** Acidulated phosphate fluoride gel can cause surface roughness on the glass ionomer cement more than sodium fluoride gel.

Keywords: acidulated phosphate fluoride, glass ionomer cements, sodium fluoride, surface roughness

Introduction

Another way to maintain tooth form caries is using fluoride. Fluoride is a mineral that helps prevent caries and can repair teeth in early stage. Fluoride can be obtained in two forms that is topical and systemic. Fluoride topical usually packed in the form of a gel, foam and varnish. According to the ADA, fluoride topical gel is more effective in preventing caries in children of bonding to the tooth, biocompatibility, and esthetics. Glass ionomers can acquire further fluoride ions following exposure to fluoridated products; such as solutions, gels and dentifrices, thereby acting as rechargeable fluoride release systems.

However, the high reactivity of the fluoride agents used in topical fluorides may result in the deterioration of the school age. Topical fluoride that is often used by dentists is acidulated phosphate fluoride (APF) gel and sodium fluoride (NaF) gel. One effort in treating dental caries in children is to restore the tooth using a restorative material. Restorative material commonly used is glass ionomer cements. This material can release fluoride that can stimulate the formation of secondary dentine, recharge ability, chemical surface properties of esthetic restorative materials. This may affect the clinical durability of the restoration. Previous study have shown that topical fluoride application could increase the surface roughness of restorative materials. Ozener (2013) showed that acidulated phosphate fluoride increased the surface roughness of Fuji IX GP and Vitremer after application for 1 min, 4 min and simulated 2 years and not for NaF application. Khosla (2014) founded that APF gel caused erosive wear of the GICs.

A rough surface on restorative materials caused the microorganism to attach to the surface of restorative materials easily. A rough surface will be more susceptible to increased bacterial colonization and plaque retention and cause discoloration.

The aim of this study is to evaluate the effect of acidulated phosphate fluoride (APF) gel and sodium fluoride (NaF) gel on the surface roughness of glass ionomer cements.
Method

Preparation of glass ionomer cylinders
Forty disc specimens of glass ionomer cement (Fuji II, GC Gold Label, Japan) were prepared using steel mould of the following dimensions 10 mm in diameter and 2 mm in thickness. The materials were mixed according to the manufacturer’s instructions and condensed into the mould. The moulds were overfilled and a cellophane strip was covered the surface and left undisturbed for 4 min at room temperature. The strips were removed and excess glass ionomer trimmed off. The bottom surface of samples was marked. Forty specimens were divided into two test groups that is application acidulated phosphate (APF) gel as group 1 and application sodium fluoride (NaF) gel as group 2.

Surface roughness measurements
The surface roughness was measured by the profilometer (MarSurf M300, Germany). To measure the roughness value, the stylus placed at the measurement point and moved across the surface horizontally along a straight line as far as 8 mm. This procedure was repeated 3 times for each specimen and the average value was considered to be the Ra value. Surface roughness was measured before and after the application of fluoride topical gel.

Application of fluoride topical gel
The top surface of the sample was divided into two parts that is top and bottom parts. Specimen in group 1 was applied with 1,23% acidulated phosphate fluoride gel (60 Second Taste Bubble Gum, Pascal International Inc., USA) and specimens in group 2 was applied with 2% sodium fluoride (GeI7, Germiphene Corporation, Canada) in horizontal direction. Then the sample is wrapped by using plastic wrap for 4 minutes. After that, the plastic wrap opened and the specimens washed thoroughly using distilled water and dried with a tissue for 1 minute.

Statistical analysis
The data obtained will be analyzed by using paired T test to find the differences of surface roughness in each treatment group and the unpaired T test to find the differences of surface roughness between the treatment groups at the 5% significance level.

Result
It was found that glass ionomer cement applied with 1,23% acidulated phosphate fluoride gel statistically significant higher surface roughness mean value (0,399±0,0171 µm) than glass ionomer cement applied with 2% sodium fluoride (0,220±0,0106 µm) as revealed by unpaired t-test.

<table>
<thead>
<tr>
<th>Test Group</th>
<th>Initial Surface Roughness(µm)</th>
<th>Final Surface Roughness(µm)</th>
<th>Changes in Surface Roughness(µm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>0,196±0,0163</td>
<td>0,399±0,0171</td>
<td>0,203±0,0084</td>
</tr>
<tr>
<td>Group 2</td>
<td>0,199±0,0134</td>
<td>0,220±0,0106</td>
<td>0,022±0,0060</td>
</tr>
</tbody>
</table>

From Table 1 we can see the changes in surface roughness highest in group 1 is 0,203 µm than group 2 is 0,022 µm.

![Graph of the change in surface roughness](image)

Figure 1. Graph of the change in surface roughness

Paired t-test analysis showed differences in surface roughness before and after application of topical fluoride gel significantly in both treatment groups with significant value of \( p = 0.00 \). Unpaired t-test also showed significant differences in surface roughness between the treatment groups with significant value of \( p = 0.00 \).

Discussion
The results showed surface roughness on glass ionomer cement applied with acidulated phosphate fluoride (APF) gel is higher than glass ionomer cement applied with a sodium fluoride (NaF) gel. Statistical analysis unpaired t-test showed a significant difference. This indicates that APF gel is more reactive than the result of surface roughness NaF gel.

APF gel contains as many as 12,300 ppm fluoride ion and pH 3.5. APF gel contains hydrofluoric acid and phosphoric acid. Hydrofluoric acid caused etching and dissolving silica particles that can cause surface roughness on the glass ionomer cement. Phosphoric acid also has the ability to dissolve the silica particles in glass ionomer cements. Hydrofluoric acid is more destructive ends of phosphoric acid for hydrofluoric acid can dissolve silica particles. In addition, the high degree of acidity on APF gel can cause a chemical reaction that causes erosion on the surface of the glass ionomer cement because the dissolution of the matrix -forming cations such as Na, Ca, Al, Sr and F. 4-7

In addition to the high acid content, a high fluorine content of APF gel can also cause surface roughness. Fluorine ions will bind to the carboxylic group to form a bond with Al3+ ions. Forming an ionic bond of fluorine
higher cause disintegration of the surface of the matrix are continually causing surface roughness on glass ionomer cement. The disintegration of the surface due to the formation of the reaction matrix polisalt contact pairs between the cation-anion or carboxylate groups with metal ions, especially bivalent aluminum particles of silica in kaca ionomer cement.\(^5\)

Whereas NaF gel containing 9.050 ppm fluoride ions with a pH of 7. The sample surface roughness after NaF gel smeared produce surface roughness less this may be caused by at least fluorine content and acidity of normal compared APF gel.

Some of the results of previous studies are also consistent with the results in this study. Prabhakar (2009) found that the APF cause significant surface roughness after applied to the glass ionomer cement and resin composite.\(^7\) Ozenen (2013) also received significant surface roughness on the glass ionomer cement and resin modified glass ionomer cements after APF gel was applied for 1, 4 and 16 minutes while the applied NaF did not change significantly.\(^5\)

This study showed an increase in surface roughness of glass ionomer cements after smeared with topical fluoride material that APF and NaF. Values of surface roughness obtained in the group smeared with APF or NaF still clinically acceptable because it is still less than or equal to 0.64 μm. Willems (1991) that the surface roughness of a restoration that is clinically acceptable to be equal to or less than the roughness email that 0.64μm.\(^8\)

Surface roughness on a restoration material can result in the growth of microorganisms of the oral cavity and food that triggers the formation of plaque. The increase in surface roughness of a material can increase the adherence of plaque and harm the teeth and periodontal tissues, causing discoloration on the surface of the material and failure fatigue. The amount of plaque correlates to the material surface roughness. Fluoride release of this material cannot prevent the attachment and growth of streptococcus mutants efficiently to the material surface.\(^6\)\(^-\)\(^9\)

**Conclusions**

The conclusion that can be drawn from the results obtained are the material of fluorine topical acidulated phosphate fluoride (APF) causes higher surface roughness on the glass ionomer cement compared to sodium fluoride (NaF).

**References**