THE EXTENT OF SECONDARY CARIES FORMATION AROUND SOME RESTORATIVE MATERIALS: AN IN VITRO STUDY

Sarah Ahmed Osama Mohamed El Ashry¹, Shaimaa Mohamed Mahfouz Omer², Mohamed Sherif Mohamed Salah El Deen Farag³

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KEYWORDS
Composite, Glass ionomer, Secondary caries.

INTRODUCTION

Secondary caries, like other dental caries is primarily caused by the activities of microorganisms in dental plaque, so it is possible for any site on the restored teeth prone to bacterial stagnation to develop secondary caries. It is primary caries at the margin of an existing restoration and not due to a defect in the restoration, usually located at plaque stagnation areas at the gingival and inter-proximal margins (¹,²).

Fluorides contribute to lowering the prevalence and severity of dental caries. It comes in contact to the minerals of the tooth surface and increase re-mineralization. Re-mineralization of secondary lesions may also occur near a fluoride-releasing dental material. The clinical
success depends on the properties of the filling material itself and its integrity in the restored cavity, and other factors such as location of the lesion, and type of the adhesive technique (3-6).

Resin composites allow minimally invasive cavity preparation, and bond to the tooth structure by adding an adhesive system to achieve good seal, and withstand polymerization shrinkage; However, marginal de-debonding may occur forming micro-cracks, and secondary caries (7-8).

Among all dental restorative materials, glass ionomers are the most cariostatic and antimicrobial due to release of fluoride which help in the prevention of secondary caries. A new material was produced based on bulk-fill glass hybrid technology which consists of strontium fluoro-alumino-silicate glass, including the newly added highly reactive small particles. This substitution of calcium with strontium enhanced the fluoride released and increased its radio-opacity (9,10).

According to our knowledge, there is no study conducted to evaluate the amount of secondary caries formation around three different restorative materials: Fuji II LC, Equia Forte, and Z100, by measuring the surface area of the lesions using Stereomicroscope.

MATERIALS AND METHODS

Table 1: Materials used in this study

<table>
<thead>
<tr>
<th>Material Name</th>
<th>Composition</th>
<th>Manufacture</th>
</tr>
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<tbody>
<tr>
<td>1- Fuji II LC</td>
<td>Resin-reinforced Glass Ionomer Material</td>
<td>GC company, United States of America.</td>
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<tr>
<td>2- Equia Forte</td>
<td>Bulk-fill Glass Hybrid Material</td>
<td>GC company, United States of America.</td>
</tr>
<tr>
<td>3- Z 100</td>
<td>Micro-hybrid Composite Resin Material</td>
<td>3M ESPE company, United States of America.</td>
</tr>
</tbody>
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Teeth Selection

This study was conducted on thirty-six premolars free from caries that were extracted due to orthodontic purposes, and collected from the Maxillofacial and Surgery Department, Faculty of Dentistry, Suez Canal University. All teeth were preserved in saline after scaling and cleaning of tissue debris for not more than 7 days till used.

Sample Grouping

In each tooth, two standardized class V cavities were prepared on the buccal and lingual surfaces with dimensions 3.0 mm mesio-distally, 1.5 mm occluso-gingivally, and 1.5 mm in depth using a high-speed straight fissure diamond bur no. 57 directed to the tooth surface at a right angle to produce a cavo-surface angle close to 90°. The dimensions were adjusted using graduated periodontal probe by drawing the cavity outline with a pencil before preparation, and the depth were adjusted by putting a marker on the bur. The prepared cavities were rinsed with distilled water, and dried with oil-free compressed air using air tip. All premolars were put in a jar and randomly assigned into three groups of twelve teeth each according to different treatment modalities using a software program for randomization (Research Randomizer*1), then restored with three different restorative materials according to manufacture instructions; Group I: Restored with Fuji II LC, Group II: Restored with Equia Forte, Group III: Restored with Z100 composite.

All teeth were thermo-cycled in a water bath for 800 cycles between 5°C and 55°C within an approximate time of 30 seconds then coated with an acid-resistant varnish around the prepared cavity (except 1 mm all around the cavo-surface margin) (11). The roots of all teeth were removed to minimize the amount of the damaged tooth and sealed with varnish. Afterwards, they were...

https://www.randomizer.org/
preserved in jars containing an acid solution for caries-like lesion formation for a duration of 5 weeks\(^{12}\). The specimens were removed and washed with water, then the crowns were sectioned buccolingually through the restoration using 0.34 mm in diameter sectioning diamond saw to produce two sections from each tooth with a total of seventy-two sections. All specimens were imbibed in water for 24 hours. Finally, the sections were examined and photographed using X30 magnifying Stereomicroscope (Leica EZ4, USA).

**Evaluation Method**

Images were analyzed using the digital software (Photoshop CC, USA) to measure the surface area of the caries lesions in mm\(^2\). De-mineralization areas were defined by the extension of whitish decalcified zone or a brown zone extending at tooth restoration interface \(^{13}\).

**RESULTS**

The results of this study showed a significant difference (P = 0.041) in secondary caries lesions formed on the buccal surface when comparing the three treated groups. The result showed that there are no significant differences on the buccal surface between Group I and Group II nor between Group I and Group III, however, there was a significant difference (P = 0.013) between Group II and Group III. Similarly, there was a significant difference (P =0.038) in secondary caries lesions formed on the lingual surface when comparing the three treated groups. Again, no difference was found between Group I and Group II nor between Group I and Group III, yet there was a significant difference (P = 0.017) between Group II and Group III (Figure 1).

Regarding the percentage of secondary caries formation on the buccal surface within each group, both Group I and Group II had an equal percentage of secondary caries formation (62.5%), while Group III showed a remarkably high percentage of secondary caries formation (95.8%). Similarly, the percentage of secondary caries on the lingual surface was highest in Group III, were all (100%) sections restored with Z100 showed secondary caries formation, compared to 70.8% of teeth in Group I and 58.3% of teeth in Group II (Figure 2).

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**Fig. (1) (a) Buccal Surface**

**Fig. (1) (b) Lingual Surface**

Fig. (1) Histogram showing mean values of secondary caries lesions on (a) buccal and (b) Lingual surface between the three treated groups.
DISCUSSION

The results of this study revealed that the amount of secondary caries at buccal and lingual surfaces in cavities restored with resin-reinforced glass ionomer and bulk-fill glass hybrid material were less compared to micro-hybrid composite resin. This may be due to better sealing ability, or due to fluoride-releasing ability of glass ionomers, a characteristic that is lacking in the resin composite, and/or less leakage around restored group filling margins. This comes in agreement with Gjorgievska et al. (14), who demonstrated the inhibitory effect of fluoride-releasing dental materials on teeth decay.

Moreover, these results agree with Hicks and Flaitz (15), and Glasspoole et al. (16), who stated that fluoride-containing restorative materials maintain a continuously increased level of fluoride release providing a notable protection against caries-like attack at tooth restoration interface. This protective effect is possibly attributed to the established fluoride uptake by enamel/dentin from fluoride-containing materials which can reach to a depth of 100 μm (17). This uptake is not lost over time, but become incorporated into the mineral component of enamel in the form of fluoridated hydroxyapatite (18). Thus, the initiation and progression of lesions notably decrease when fluoride is incorporated into the enamel, dentin, and cementum.

In this study, the amount of secondary caries lesions that were formed in teeth restored with bulk-fill glass hybrid material were slightly lower than that formed in cavities filled with resin-modified glass ionomer. This discrepancy is possibly related to the degree of fluoride release associated with each restorative material.

This is in agreement with Okida et al. (19), who observed a significant reduction in de-mineralization related to the apparent fluoride released from bulk-fill glass ionomer. Zebic et al. (20) further compared the amount of fluoride released from four different glass ionomer restorations and they concluded that the highest amount of fluoride was released from the glass hybrid material, while the resin-modified glass ionomer produced the least amount in vitro. This proves that the new glass hybrid material can resist caries-like attack at the enamel-restorative interface providing more protection against secondary caries formation.

The increase of carious lesions in teeth restored with micro-hybrid composite is not solely attributed to the absence of fluoride, as the widened gap surrounding the restoration can also be a contributing factor. This coincides with the findings by Yaman et al. (21), and Donly et al. (22), who showed that caries lesions were significantly higher when composite resin and compomer were used as compared to glass ionomer cements.
CONCLUSION

Glass ionomer has an inhibitory effect on formation of secondary caries lesions. The new fluoride releasing glass hybrid material seems to resist caries attack more than the resin reinforced glass ionomer materials, though statistically non-significant. Composite resin restoration is not an effective material on preventing secondary caries lesions.

REFERENCES