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

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Composite, Glass ionomer, Secondary caries.

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ABSTRACT

Introduction: Dental restorations are widely used in dentistry as the most common way to replace the lost parts of the tooth that occur due to decay. Secondary caries is the primary cause of replacing an existing restoration. Nowadays, modified restorations were introduced to the market to solve the drawbacks of the conventional ones in respect to the early loss of strength, and moisture sensitivity. New dental restorations are possibly associated with lesser degree of secondary caries formation. **Aim:** Evaluate secondary caries formation around three different restorative materials by measuring the surface area of the lesions using stereo-microscope. **Materials and Methods:** Thirty-six human premolar teeth were collected from the Outpatient clinic of the Maxillofacial Department, Faculty of Dentistry, Suez Canal University, and were divided into three groups according to the type of restoration used. *Group I* restored with Fuji II LC material, *Group II* restored with Equia Forte material, and *Group III* restored with Z100 material according to manufacture instructions. All teeth were preserved in an artificial caries solution for 5 weeks, and then divided into thin sections to be evaluated under Stereomicroscope to assess secondary caries lesions formed around restorations. **Results:** There was statistically significant difference between secondary caries values on both the buccal and lingual surfaces of the three groups. Equia Forte *(Group II)* showed the least secondary caries lesions followed by Fuji II LC *(Group I),* while the highest values were recorded at Z100 *(group III)*. **Conclusion:** Glass ionomer have an inhibitory effect on formation of secondary caries, which is higher in glass hybrid ionomer compared to resin-reinforced glass. Composite resin restoration is not an effective material on preventing secondary caries lesions.

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*

Material Name	Composition	Manufacture
1- Fuji II LC	Resin-reinforced Glass Ionomer Material	GC company, United States of America.
2- Equia Forte	Bulk-fill Glass Hybrid Material	GC company, United States of America.
3- Z 100	Micro-hybrid Composite Resin Material	3M ESPE company, United States of America.

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 bucco-lingually 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**).

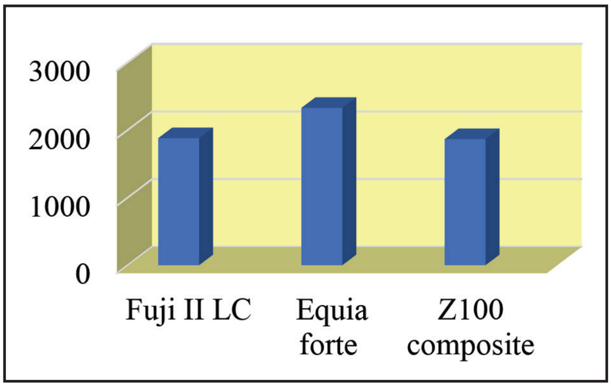

Fig. (1) (a) Buccal Surface

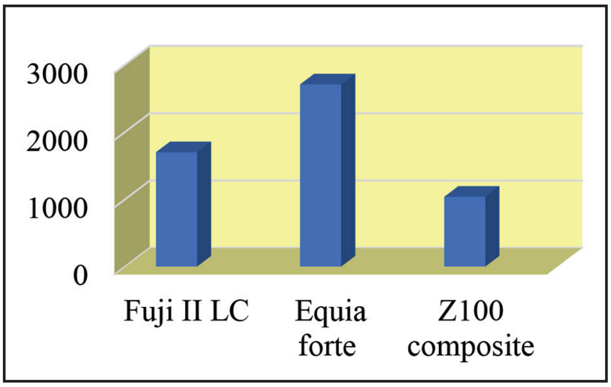

Fig. (1) (b) Lingual Surface

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

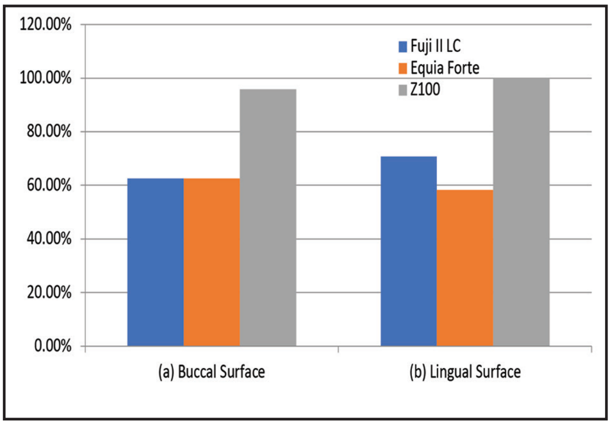

Fig. (2) Distribution of teeth according to presence of secondary caries lesions on (a) buccal and (b) lingual surface between the three treated groups

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

1. MjorIA. Frequency of secondary caries at various anatomical locations. Oper Dent1985;10:88-92.
2. Mjor IA. Clinical diagnosis of recurrent caries. J Am Dent Assoc 2005; 136:1426-1433.
3. Kohn WG, Maas WR, Malvitz DM, Presson SM, Shaddix KK. Recommendations for using fluoride to prevent and control dental caries in the united states. Centers for disease control and prevention. MMWR Recomm Rep 2001;50:1-42.
4. Buzalaf MAR, Pessan JP, Honório HM, Ten Cate JM. Mechanisms of action of fluoride for caries control. Monogr Oral Sci 2011;22:97-114.
5. Bynum AM, Donly KJ. Enamel de/remineralization on teeth adjacent to fluoride releasing materials without dentifrice exposure. ASDC J Dent Child 1999;66:89-92, 84.
6. Schwendicke F, Göstemeyer G, Blunck U, Paris S, Hsu L-Y, Tu Y-K. Directly placed restorative materials. J Dent Res 2016;95:613-622.
7. De Munck J, Van Meerbeek B, Yoshida Y, et al. Four-year water degradation of total-etch adhesives bonded to dentin. J Dent Res 2003;82:136-140.
8. Soares CJ, Faria-E-Silva AL, Rodrigues M de P, et al. Polymerization shrinkage stress of composite resins and resin cements - what do we need to know? Braz Oral Res 2017;31:e62.
9. Ching HS, Luddin N, Kannan TP, Ab Rahman I, Abdul Ghani NRN. Modification of glass ionomer cements on their physical-mechanical and antimicrobial properties. J Esthet Restor Dent 2018;30:557-571.
10. Shahid S, Hassan U, Billington RW, Hill RG, Anderson P. Glass ionomer cements: effect of strontium substitution on esthetics, radiopacity and fluoride release. Dent Mater 2014;30:308-313.
11. Naik N, Subba Reddy V, Shashikiran N. Comparative evaluation of secondary caries formation around light-cured fluoride-releasing restorative materials. J Indian Soc Pedod Prev Dent 2017;35:75-82.
12. Turkistani A, Nakashima S, Shimada Y, Tagami J, Sadr A. Microgaps and demineralization progress around composite restorations. J Dent Res 2015;94:1070-1077.
13. Farag A, Amer M. Detection of in vitro secondary caries adjacent to restorations using cone-beam computed tomography. EDJ 2011;57:907-919.
14. Gjorgievska E, Nicholson W J, Iljovska S, Slipper I. The potential of fluoride-releasing dental restoratives to inhibit enamel demineralization: An SEM study. Prilozi 2009;30:191-204.
15. Hicks MJ, Flaitz CM. Resin-modified glass-ionomer restorations and in vitro secondary caries formation in coronal enamel. Quintessence Int 2000;31:570-578.
16. Glasspoole EA, Erickson RL, Davidson CL. Demineralization of enamel in relation to the fluoride release of materials. Am J Dent 2001;14:8-12.
17. Mitra SB. Adhesion to dentin and physical properties of a light-cured glass-ionomer liner/base. J Dent Res 1991;70:72-74.
18. Hicks MJ, Flaitz CM, Silverstone LM. Initiation and progression of caries-like lesions of enamel: effect of periodic treatment with synthetic saliva and sodium fluoride. Caries Res1985;19:481-489.
19. Okida RC, Mandarino F, Sundfeld RH, de Alexandre RS, Sundefeld MLMM. In vitro-evaluation of secondary caries formation around restoration. Bull Tokyo Dent Coll2008;49:121-128.
20. Zebić ML, Jakovljević N, Miletić V. Fluoride release from conventional, resin-modified and hybrid glass ionomer cements. Serbian Dent J 2019;65:187-194.
21. Yaman SD, Er Ö, Yetmez M, Karabay GA. In vitro inhibition of caries-like lesions with fluoride-releasing materials. J Oral Sci 2004;46:45-50.
22. Donly KJ, Liu JA. Dentin and enamel demineralization inhibition at restoration margins of vitremer, z 100 and cention n. Am J Dent 2018;31:166-168.