Original Article

Received: Nov.17-2013
Accepted: Feb.3-2014

Microleakage of Class V Compomer and Light-cured Glass-ionomer Restorations under Load Cycling: An in Vitro Investigation

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Abstract

Statement of the problem: Tooth restorations are exposed to stresses which produce marginal gaps resulting in microleakage.

Purpose: In this study, microleakage of light-cured glass-ionomer and compomer class V restorations was evaluted and compared under cyclic loading.

Materials and Methods: In this exprimental study, class V cavities were prepared on the buccal surfaces of maxillary premolars (n=40). The teeth were randomly divided into two equal groups. Samples in one group were restored with Compoglass and those in the other group were restored with Fuji II LC. All the samples were thermocycled for 2500 cycles. Each group was subjected to cyclic loading (10000 cycles). Dye peneteration method was used for samples. Finally, microleakage of the restorations was evaluated under a stereomicroscope at ×20. Data were analyzed with chi-squared test. The confidance level was set at 95% (α=5%).

Results: Microleakage was observed at 55% of restoration margins with both materials, with more leakage in the Compoglass group. The results showed no statically significant differences between the two groups (P>0.05). In addition, no significant differences were seen in microleakage between gingival and occlusal margins (P=0.64 and P=0.7, respectively).

Conclusion: Microleakage of Compoglass and Fuji II LC restorations was not different at margins under cyclic loading.

Keywords: Microleakage, Compomers, Glass Ionomer Cements, Load Cycling.

INTRODUCTION

Marginal sealing of restorative material is an essential factor in evaluating longevity of restorations.[1] Lack of adaptation of restoration to the cavity walls can lead to marginal leakage, resulting in staining, postoperative sensivity, pulpal irriation and recurrent caries.[2,3]

The search for a restorative material with adhesive and caries protective properties,

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as well as, ease of handeling has resulted in the introduction of resin-modified glass–ionomers and polyacid-modified composite resins (compomers). However, the resin content of these materials produces polymerization shrinkage which might adversely affect marginal adaptation.[4]

It has been reported that occlusal stresses are concentrated in the cervical region.[5] This is believed to be the result of different types of stresses generated at the tooth–restoration interface during tooth function. These stresses are more critical in class V restorations because these restorations may undergo flexure along with tooth during mastication and these flexural effects may be enhanced by malocclusion.[6]

Samer et al showed more microleakage of compomer Class V restorations occurring at occlusal margins than at gingival margins.[7] Mali et al found that glass-ionomers have maximum leakage followed by composite resin. Compomer demonstrated the best results with minimum leakage. Occlusal loading increased the microleakage values in enamel and dentin.[8] Xie et al showd that both flowable composite resin and compomer provided higher dentin bond strength valuess and better margin sealing than the conventional glass-ionomer cement. Occlusal forces exerted the same effects on microleakage of the occlusal margin and gingival margin in cervical cavities. Although, several in vitro studies have been conducted to investigate the microleakage of class V compomer and light-cured glass-ionomer,[9-11] the effect of cyclic loading on marginal seal of these materials at cervical and occlosal margins remains unclear.[12]

Therefore, the aim of this in vitro study was to evaluate marginal adaption of a compomer and a light-cured glass-ionomer under cyclic loading.

MATERIALS AND METHODS

In this exprimental study, fourty extracted human upper premolar teeth free of visible caries and defects were selected. The samples were cleaned of debris and calculus by a surgical knife and stored in 0.1% thymol solution. The samples were kept in distilled water 24 hours before the experiment.

Class V cavity was prepared on the buccal surface of each tooth at the cementoenamel junction (CEJ) so that half of the cavity was above the CEJ and half below. Preparation was carried out with #245 diamond fissure bur (D&Z, Berlin, Germany) at high speed with adequate water cooling. After five cavity preparations, the bur was replaced. Cavity dimensions were: 3 mm in width, 2 mm in height and 1.5 mm in depth. Subsequently, the teeth were randomly assigned to two equal groups of 40 teeth. The resin-modified glass-ionomer used in this study was Fuji II LC (GC Corp, Tokyo, Japan) and the compomer was Compoglass (Vivadent, Ets, Schaan, Liechtenstein, Germany). Each material was placed incrementally according to manufacturer's instructions. Immediately after light curing, restorations were finished with wet abrasive disks (Sof-flex xt, 3M Dental Products, USA). The teeth were placed in separate mesh bags and thermocycled together for 2500 cycles in water between 5±2°C and 55±2°C with a dwell time of 1 minute in each bath and 15 seconds of transfer time between the baths.

The root of the samples were covered with ultra-thin (0.006 inch) foil; then the samples were mounted in an upright position in the center of plastic tubes #2 (1.8 cm) up to 2 mm below the apical margin of the restoration that was filled with acrylic resin (Acropars, Tehran, Iran). The samples were kept in a water container for 24 hours. After completion of acrylic resin curing, the teeth were extracted and the residual spaces was filled with impression material (Light Body Speedex, Coletene, Switzerland). After removing the foil layer, the samples were again inserted in their previous places.

Cyclic loading was performed with Instron testing machine (Zwick, ulm, Germany) under approximately 110-N axial load. The loading was repeated 10000 times at a rate of 3 cycles/second. Then, the samples were separated from the mold and immersed in a 10% methylene blue solution for 72 hours at room temperature.[13] All the external surfaces of each tooth were coated with two layers of nail varnish except for 1.5 mm around the restoration. The samples were sectioned in faciolingual direction through the center with a cooled low-speed diamond disk (Isomet, Buehler Ltd, Lake Bluff, IL, USA).

Each section was assessed under a stereomicroscope at ×20.

The following criteria were used to score microleakage:

0=no dye penetration.

1=dye penetration to ½ of cavity depth.

2=dye penetration to 2/3 of cavity depth.

3=dye penetration to greater than 2/3 of cavity depth.

Data were analyzed with chi-squared test. Level of confidence was set at 95% (α=0.05).

RESULTS

Means and stundard diviasions of microleakage values of the groups studied are presented in Table 1.

Statistical analysis demonstrated no significant differences in microleakage between the two groups at occlusal margins (P=0.7).

In addition, microleakage of Compoglass group exhibited no significant difference from the light-cured glass-ionomer group under cyclic loading at gingival margins (P=0.64). Comparison of all the specimens showed that there was more microleakage at dentin margins than at the enamel margin (P<0.05).

Table 1: Microleakage values of the two groups under load

		0 N (%)	1 N (%)	2 N (%)	3 N (%)	Total N (%)
Compoglass	cervical	3 (15%)	11 (55%)	3 (15%)	3 (15%)	20 (100%)
	occlusal	9 (45%)	6 (30%)	4 (20%)	1 (5%)	20 (100%)
Fuji II LC	cervical	3 (15%)	9 (45%)	6 (30%)	2 (10%)	20 (100%)
	occlusal	6 (30%)	9 (45%)	3 (15%)	2 (10%)	20 (100%)

DISCUSSION

The marginal integrity of a restorative material in cervical lesions plays an important role in prevention of microleakage. Microleakage due to marginal gaps between the restoration and the cavity walls are attributed to shrinkage stress.(12)

Some studies have pointed to stresses created by actual flexure of tooth during natural function as a factor facilitating marginal gap formation.(14) Glass-ionomer has some characteristics that make it suitable for repair of cervical lesions (without cavity preparation).

One of these is chemical bonding to the enamel and dentin. In addition, it has anti-cariogenic activity and can be used instead of or as a constituteent of dentin but in comparison with composite resins it is less esthetic.(15) On the other hand, compomers are combined technology of composite resin and glass-ionomer; therefore, they have the advantages of both materials.(16)

Lee and Eakle (17) were the first investigators suggesting that occlusal forces on teeth could be a causative factor in the development of non-carious cervical lesions. It has been hypothesized that when cervical lesions are restored and subjected to stresses, these stresses cause translocation of class V restoration at cavosurface edges.

A photoelastic study revealed that constant exertion of compressive and tensile stresses on the tooth–material interface in cervical restorations may lead to an increase in the amount of microleakage because of deterioration of marginal integrity or the actual dislodgment of the restoration.(18)

Jerjenson and Matono found that cyclic loading on restored teeth may cause transient or permanent gaps.(19) In the present study, cyclic loading had no significant effect on microleakage in both restoration groups.

Davidson and Abdalla suggested no significant effect of cyclic loading on Fuji II when the samples were subjected to 5000 cycles.[20] However, Rigsby et al reported that composite restorations exhibited an increase in microleakage at cervical margin. This increased microleakage was due to both thermocycling and load cycling.[21]

In the present study, load cycling did not have any significant effect on microleakage even when combined with thermocycling. The applied load was axial in this study. Derbyshire also used same load in their study.[22]

This study demonstrated a higher incidence of microleakage at cervical margins in two groups. This difference was significant in Compoglass restorations. More microleakage in the Compoglass gourp is probably due to resin content of this material, which results in polymerisatoin shirinkage and finally marginal gaps; however, in the present study, there were no significant differences between two groups. Although single-component compomer is less susceptible to voids than a mixed material, the varied handling characteristics of the material did not seem to be an important factor in marginal leakage. The comparision of microleakages of margins showed that it was greater at cervical than occlusal margins. These results are in agreement with previous researches.[23,24] Since this study was carried out in vitro, future studies are recommended with conditions close to the oral enviroment and as clinical trials.

CONCLUSIONS

Under the limitations of this study, it can be concluded that:

1. Microleakage of Compoglass and Fuji II LC groups at margins was similar at occlusal and cervical margins under cyclic loading.
2. The overall microleakage at gingival margins was more than that at occlusal margins.

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