

A comparative study of microleakage between giomer and ormocer restoration in class I cavity of first permanent premolar teeth *in vivo*

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Article Info

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Abstract

This study was performed to compare the marginal microleakage of ormocer restorative material with that of giomer *in vivo*. Forty Class I cavities were prepared in non-carious permanent premolar teeth from 10 patients. Twenty cavities were filled with giomer and the remaining 20 cavities were filled by ormocer restorative materials. After one month, teeth were extracted, immersed in rhodamine dye solution, and then longitudinally bisected to assess the degree of dye penetration by stereoscopy. Furthermore, the gap between the dental material and tooth tissue were observed by the scanning electron microscope. The results showed that no microleakage (score 0) was detected in 15 ormocer and 5 giomer restorations. The remaining restorations were associated with dye penetration which was due to gap formation as seen in stereoscopic and scanning electron microscopic observations. The differences between ormocer and giomer restorative materials in respect to dye penetration were statistically significant. It can be concluded that ormocer restorative material shows less microleakage than that of giomer.

Introduction

In dentistry, the loss of tooth structure due to caries, fracture or wear can be replaced or repaired to restore the tooth to its form and function. However, microleakage of a restoration is one of the main reasons for its failure.¹ Microleakage means passage of bacteria, fluids, molecules, ions along the various gap present in the cavity/restoration interface.¹ Clinically, the majority of restorative materials show varying degree of marginal microleakage either due to changes in dimension or a lack of good adaptation to cavity walls.² Marginal microleakage results in the development of secondary carious lesions, pulpal pathology, post-operative pain and sensitivity. They are all responsible for the potential failure of the restoration.³ To reduce microleakage, many authors have been suggested to improve the bond strength of a restoration.

Resin composite and adhesive material have been investigated and further developed since their introduction, with an attempt to find an adequate alternative to the dental amalgam.² Composite resin restoration is considered as having good bond strength due to excellent development of adhesive technology, but unfortunately microleakage is still continued. To solve the above mention problems, fluoride-releasing light-cured restorative material

named giomer, which contains pre-reacted glass ionomer filler has been developed.⁴ Giomer is based on the inclusion of surface pre-reacted glass-ionomer filler into a resin matrix. It combines the advantages of composite and glass ionomer.⁵ Therefore, its use in the dental practice is expected by many of the previous studies. Although the long-term fluoride release of gomers is questionable,⁶ a recent research study reported that gomers have demineralization inhibition properties similar to glass-ionomers, *in vitro*.⁷ Like compomers, giomer is light polymerized and requires the use of a bonding system for adhesion to tooth structure.

Recently, a new restorative material called ormocer has been developed, which is originally a modified ceramic material.⁸ It contains ceramic polysiloxane, inorganic silanated filler particles. The filler particles are 1-1.5 μm in size.⁹ This material also presents 77-78 weight% of filler loading, 61% filler volume, and a modulus of elasticity of 10.700MP.⁹ Ormocer has low shrinkage, high abrasion resistance, biocompatibility, and protection against caries.¹⁰ Moreover, the use of silicon dioxide provides them with their name and accounts for their relationship with ceramics. They combine glass-like (inorganic) constituents with polymer (organic) constituents. Although many studies have been performed regarding the



microleakage of glass ionomer, composite rein and resin modified glass ionomer cements. However, there is no study been performed using giomer and ormocer restorative materials. Therefore, in the present study, the degree of microleakage of giomer and ormocer in Class I cavity were evaluated, *in vivo*.

Materials and Methods

This randomized clinical trial study was performed during the period of January to December 2016. Patient attending in the Department of Orthodontics of Bangabandhu Sheikh Mujib Medical University and Dhaka Dental College Hospital for correction of aesthetic disorder, were selected for this study.

Sample preparation

Forty non-carious permanent premolar teeth from 10 participants (4 teeth of each participant), who need extraction of their teeth for orthodontic reasons, were used as study population. These teeth were divided by traditional lottery method of which 2 teeth will be used for giomer and two for ormocer in each participant. Therefore, as a total, among the 10 patients, 20 teeth were used with giomer (Group A) and 20 teeth for ormocer (Group B).

Cavity preparation

After mouth preparation of each patient, Class I cavities were prepared to a size of 3×2×2 mm dimension by using a flat end fissure bur (Shofu Dental Corporation, Japan) with a high speed hand piece under sufficient cooling arrangement. Class I cavity preparation was performed on the occlusal surface of each tooth.

Restoration

In Group A, after completing the cavity preparation, all the cavities were assigned to the one step self-etch adhesive system (Giomer Beauti-Bond, Shofu, Japan) according to manufacturer's instructions. Adhesive systems were then cured for 10 sec with a light cure machine. The restoration was

completely filled by giomer (Beatifil) increments each layer not being more than 2 mm and were cured for 20 sec. Then the restorations were finished under water cooling with fine and superfine diamond points and polished with super buff disk.

In Group B (ormocer), after completing cavity preparation, all the cavities were assigned to the one step self-etch adhesive system (Admira Bond) according to manufacturer's instructions. Adhesive systems were cured for 10 sec with a light cure machine. The restorations were completely filled by ormocer (Admira) increments each layer not being more than 2 mm and were cure for 20 sec. Then the restorations were finished under water cooling with fine and superfine diamond points and polished with super buff disk. All patients were advised to maintain their normal life style such as to take their normal diet. They were also advised to maintain strictly oral hygiene instructions.

Evaluation

After one month, all teeth were extracted and cleaned. The tooth surfaces except the restoration and a 1 mm zone adjacent to its margin were covered with two coats of nail burnish. The root apices were sealed with sticky wax. Samples were then immersed in a rhodamine dye solution for 24 hours at room temperature. The degree of dye penetration was assessed according to a previous study.¹¹ Teeth and restorations were longitudinally bisected with a diamond saw wheel machine and the degree of microleakage was scored in a blinded manner based on a grade-scale criteria, (0 = no dye penetration; I = dye penetration reaching the enamel, II = dye penetration reaching the dentin; III = dye penetration reaching cavity floor) under stereoscope at 20x by a technician who was not informed of the true nature and purpose of this experiment. Thus, judgment of the degree of dye penetration was kept blind. Where scores were not similar at both sides, the higher degree of microleakage score were used. Furthermore, the gap between restoration and tooth tissues interfaces were also assessed by the scanning electron microscope. Cut surfaces were polished by wet silicon carbide paper, and then observed by the scanning electron microscope. The degree of dye penetration and the gap between the restorations and tooth tissue were recorded.

Statistical analysis

Statistical significant differences between two groups were performed by Chi square test. P value of <0.05 was considered as statistically significant.

Results

The results of dye penetration test revealed that 5 out of 20 restorations in Group A (giomer) revealed

Table I

Dye penetration and gap test

Grade		Giomer (n=20)	Ormocer (n=20)	p value
Grade 0 (No dye penetration)		5	15	0.004
Grade I (Dye penetration up to enamel)		7	5	
Grade II (Dye penetration up to dentin)		3	0	
Grade III (Dye penetration on cavity floor)		5	0	
Gap test	Absent	5	15	0.004
	Present	15	5	

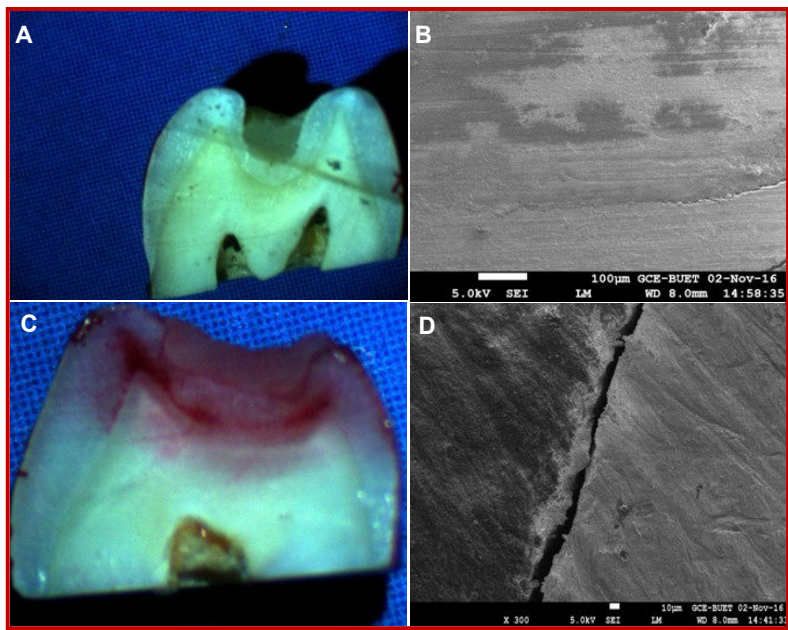


Figure 1: Representative photographs of giomer restoration subjected to dye penetration test. (A) stereoscopic view of dye penetration (score 0); (B) Scanning electron microscope view of intact tooth-tissue interface; (C) Stereoscopic view of dye penetration (score 3); (D) Scanning electron microscope view of gap formation at tooth-tissue interface

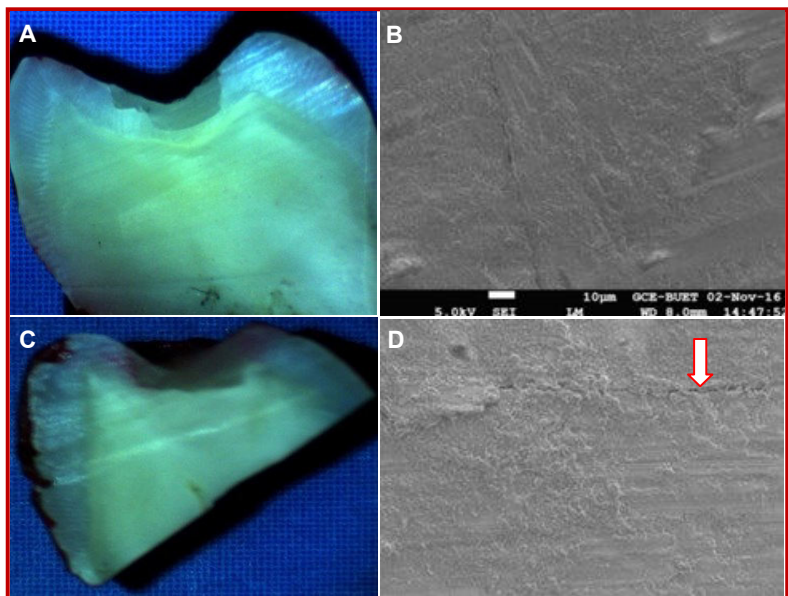


Figure 2: Representative photographs of ormocer restoration subjected to dye penetration test. (A) stereoscopic view of dye penetration (score 0), (B) Scanning electron microscope view of intact tooth-tissue interface (C) Stereoscopic view of dye penetration (score 1), (D) Scanning electron microscope view of gap formation at tooth-tissue interface

no microleakage in stereoscopic observation (Table I; Figure 1A). Scanning electron microscope observation revealed no gap between the restoration and tooth tissue interface of these samples (Fig. 1-B). However, the remaining restorations were associated with some degree of dye penetration which was

as follows: 7 restorations showed Grade I dye penetration, 3 showed Grade II and 5 revealed Grade III dye penetration. It was also revealed that giomer restorations associated with dye penetration was due to gap formation as seen in stereoscopic and scanning electron microscope observation (Figure 1CD).

On the other hand, due to good adaptation with enamel and dentin, no dye penetration (score 0) was detected in 15 ormocer restorations in Group B as seen in stereoscopic observation (Table I; Figure 2D). Scanning electron microscope observation of these samples also showed no gaps in between the tooth tissue and ormocer restorations (Figure 2B). However, the remaining 5 ormocer restorations showed Grade I dye penetration which was limited to enamel only (Figure 2C). When these restorations were observed by the scanning electron microscope, it was revealed that microleakage was due to a gap formation between tooth tissues and the ormocer restoration (Figure 2D). Furthermore, ormocer also showed less microleakage which was statistically significant than that of giomer restoration.

Discussion

Many previous studies have indicated that the success of the restoration is associated with control of microleakage which may occur due to dimensional changes or lack of adaptation of the restorative material into the cavity preparation, that may lead to recurrent caries and pulpal pathosis.^{1,12}

The assessment of microleakage in dental restorations has been performed *in vitro* and *in vivo* studies.¹³ Several methods have been proposed to measure the level of microleakage. These includes the application of compressed air, bacteria, chemical, and radioactive markers, as well as electrochemical investigations, scanning electron microscopy, dye penetration,¹⁴ and recently micro-CT images.¹⁵ However, these methods are difficult to stimulate between *in vitro* and *in vivo* studies.¹³ Furthermore, few *in vivo* studies have been performed to detect dye penetration degree in dentistry due to the application of the restorative materials *in vivo* is more difficult than their application *in vitro* on extracted teeth. It can be considered that if an *in vivo* study could be performed with care, an adequate seal *in vivo* could not be difficult to obtain. Therefore, in the present study, dye penetration degree of ormocer and giomer was performed *in vivo* to reduce the differences of the results found in different *in vitro* studies.

In the present study, to assess the degree of microleakage of giomer and ormocer restorations *in vivo*, the degree of dye penetration was observed by

electron microscope. In respect to dye penetration, the results of the present study revealed that due to good adaptation with enamel and dentin, no microleakage (score 0) was detected in 15 ormocer and 5 giomer restorations as seen by stereoscopic observation. Scanning electron microscope observation also revealed no gaps between the restorations and tooth tissues. Furthermore, the differences of dye penetration between ormocer and giomer restoration were statistically significant. The results were corresponded to a previous study that ormocer showed significantly less microleakage than that of giomer restoration.¹⁶ It was equally effective in reducing microleakage than the other flowable compomer.¹⁷ Furthermore, an *in vivo* study indicated that overall clinical behavior of the ormocer material is acceptable up to 1 year.¹⁸

However, 5 ormocer restorations showed Grade I dye penetration which is limited to enamel only. It was also found that microleakage was due to a gap formation between the ormocer restoration and tooth tissues as seen by stereoscopic and scanning electron microscope observation. Gaps can be produced due to polymerization shrinkage or due to inadequate adaptation of the restorative material with tooth tissue, less penetration of the material or its insufficient curing. There may also be entrapped air when placing the restorative materials into the cavities. Furthermore, one previous study reported that marginal microleakage could be found with all the dental restorative material.¹⁹ In the present study, it was found that microleakage was limited in the enamel surface only (score 1), which indicates that microleakage was restricted to margin of the restoration, which is known as marginal microleakage. It can also be considered that marginal leakage may lead to marginal discoloration could be easily repaired by restorative materials without removing it.

On the other hand, 5 giomer restorations revealed no microleakage in stereoscopic observation. Scanning electron microscope observation also revealed no gap between restoration and tooth tissue interface. However, the remaining restorations were associated with some degree of dye penetration as follows: 7 restorations showed Grade I dye penetration, 3 showed Grade II and 5 revealed Grade III dye penetration. Again giomer restorations associated with dye penetration was due to gap formation as seen stereoscopic and scanning electron microscope observation. The results of comparison between ormocer and giomer restorations revealed that ormocer showed less microleakage which was statistically significant than that of giomer restorations. When comparing the ormocer with giomer restorative material, it is said that ormocer matrix is a polymer even prior to light curing, it consist of polysiloxone, which has low shrinkage as against the organic demethacrylate monomer matrix seen in composite. Furthermore, incorporation of filler particles decreases the volumetric shrinkage. That might be the possible reason of less microleakage in ormocer restorations of the present study.

Conclusion

Ormocer restorations are capable of decreasing microleakage *in vivo* study and its efficiency is better than that of giomer restorations.

Ethical Issue

The study was approved by the Institutional Review Board of Bangabandhu Sheikh Mujib Medical University.

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