ORIGINAL RESEARCH

Comparative Assessment of Marginal Micro Leakage of Different Esthetic Restorative Materials Used on Primary Teeth: An *In-vitro* Study

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Abstract

Aim: The aim of the current investigation was to evaluate the marginal microleakage of various esthetic restorative materials applied to primary teeth.

Materials and methods: A total of 75 noncarious primary molars that were removed for orthodontic intervention and teeth nearing exfoliation were chosen. One millimeter (mm) above the cementoenamel junction, on the buccal surface of the teeth, Class V cavities were prepared. William's graded periodontal probe was used to standardize cavity preparation on all teeth. 3 mm was the cavity's length, 2 mm in width, and 2 mm in depth. The teeth were then divided into three groups (25 samples in each group) according to the type of esthetic restorative material used. Group I: Resin-modified glass ionomer cement, Group II: Ormocer, Group III: Giomer. The samples underwent 500 cycles of thermocycling, with an immersion time of 60 seconds and a well time of 15 seconds, between 5 and 55°C. The samples were submerged in methylene blue dye for 24 hours at room temperature and dried. The samples were then divided into sections and examined with a stereomicroscope. Data was recorded and statistically analyzed.

Results: The least marginal microleakage was found in the ormocer group (1.22 ± 0.01) followed by resin-modified glass ionomer cement group (1.31 ± 0.07) and the giomer group (1.78 ± 0.03). There was a highly statistically significant difference found between resin-modified glass ionomer cement group and the ormocer group, resin-modified glass ionomer cement group and giomer group. And no significant difference was found between the ormocer group and the giomer group.

Conclusion: The present study concluded that there was some amount of microleakage in primary teeth in all restorative materials examined in this *in-vitro* investigation. However, the marginal sealing ability of ormocer was found highest compared to resin-modified glass ionomer cement and Giomer materials.

Clinical significance: The primary reason dental restorations fail, particularly in Class V cavities, is microleakage since the margins of these restorations are typically found in the dentin or cementum. Assessing microleakage is a crucial step in determining the marginal integrity of restorative materials. Developing methods and resources that reduce the adverse effects caused by the restorative marginal seal failing would benefit from this.

Keywords: Class V cavity, Esthetic restorative materials, Micro leakage, Primary teeth.

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Introduction

Dental caries is a global oral health issue that has the highest incidence and prevalence of any dental disease. All across the world, dental caries are very common among children. Primary teeth are thought to be of paramount relevance, and maintaining their health is a top health priority because they are particularly sensitive to decay and serve as the basis for permanent teeth. Precautionary tooth preparation and long-lasting restorative materials that continue to work until exfoliation time are essential for treating primary teeth that have decay.[1]

Preventing microleakage is a crucial prerequisite for the successful completion of restoration, and this is accomplished by ensuring that the restorative material is well adhered to the cavity walls. Because the restorative materials are insufficient to achieve the full marginal seal, micro fissures can form. These can allow fluids, ions, and bacteria to seep in, resulting in pulpal infections, secondary decay, and sensitivity.[2] The chemically undetectable movement of molecules, ions, fluids, or bacteria between the cavity walls and the restorative materials is known as microleakage.[3]

Many better restorative materials have been developed as a result of the significant advancement in the need for cosmetic dentistry over time. Right now, the longevity and limited seal integrity of these materials are the primary performance problems. Despite technical innovations and restorative material improvements, microleakage is still a concern in clinical practice. Class V cavities were restored using earlier amalgam and gold restorative materials, but these materials eventually became outdated due to esthetic concerns. In order to restore Class V

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cavities, restorative materials such as glass ionomers, hybrid ionomers, compomers, and composite resins are now advised.[4] Class V cavities are characterized by little to no enamel at the cervical margins, which has been deemed to be extremely difficult to achieve sufficient adhesion.[5]

Resin-modified glass ionomer cement (RMGIC) is a biocompatible and fluoride-releasing material with enhanced physical qualities, particularly in terms of tensile strength and abrasion resistance, greater wear resistance, good adherence to enamel and dentin, and satisfactory esthetics. Giomers have qualities including biocompatibility, outstanding esthetics, and fluoride release and recharge.[6] Organically altered ceramic is called Ormocer. This novel material serves as the best and most modern substitute for amalgam, composites, and polymers for all filling indications in the anterior and posterior regions.[7] Only limited evidence exists on comparison between these materials on primary teeth. Hence, the purpose of the present *in vitro* study was to investigate the amount of dye penetration as an estimation of the microleakage of three esthetic restorative materials on primary teeth.

Materials and Methods

Sample Preparation

The present *In vitro* study was conducted in the College of Dentistry, Prince Sattam Bin Abdulaziz University, Saudi Arabia, during the year 2023. A sample size of 25 primary molars with an alpha of 0.05 and a beta of less than 0.2 (power > 80%) was computed for each group. The study included a total of 75 noncarious primary molars that were extracted for orthodontic intervention and teeth nearing exfoliation. To eliminate any remaining biological tissue, ultrasonic equipment was used for scaling and root planning on each of the chosen teeth. After that, in order to avoid dehydration, the teeth were kept in room temperature distilled water until used. On the buccal surface of the teeth, one millimeter (mm) above the cementoenamel junction, Class V cavities were prepared. Using a high-speed airotor handpiece with a cylindrical diamond point, the cavity was prepared. William's graded periodontal probe was used to standardize cavity preparation on all teeth. Three mm was the cavity's length, two mm in width, and two mm in depth. The teeth were then divided into three groups (25 samples in each group) based on the esthetic restorative material.

Group I: Resin-modified glass ionomer cement (Vitremer 3M Dental product, USA)

Group II: Ormocer (Admira Flow, Voco, Cuxhaven, Germany)

Group III: Giomer (Beautifil, Shofu Inc. Kyoto Japan)

Each restorative material was placed in the prepared cavity with the help of a plastic filling instrument and condensed with the help of a condenser. And prepared cavities were restored according to the manufacturer's directions. Two trained and calibrated investigators participated in the present study.

Thermocycling and Dye Penetration

The samples received 500 cycles of thermocycling, with an immersion time of 60 seconds and a well time of 15 seconds, between 5 and 55°C. The entire dental structure received two coats of nail polish, with a 1 mm window left around the outer margins of the cavities. Following a 24-hour period at room temperature, the teeth were submerged in 2% of methylene blue dye and allowed to dry. Before assessing the accuracy of dye penetration, the samples were thoroughly cleaned with distilled water to get rid of any excess dye that might have been left on the material or the tooth surface. With a micromotor straight handpiece situated on a diamond disc, the samples were sectioned through the middle of the restoration in both the buccolingual and occlusal-cervical directions. Under a stereomicroscope with a 40x magnification, the sectioned samples were examined.

Table 1: Comparison of mean microleakage of three different esthetic restorative materials

Experimental groups	*Mean ± Std. deviation*	*f-value*	*p-value*
Group I – Resin modified glass ionomer cement	1.31 ± 0.07	19.175	0.001***
Group II – Ormocer	1.22 ± 0.01		
Group III – Giomer	1.78 ± 0.03		

***Highly significant

Table 2: Overall comparisons of mean microleakage of three different restorative materials

Experimental groups	*Comparison with*	*Mean Difference (I–J)*	*Significance*
RMGIC	Ormocer	0.09	0.087
	Giomer	–0.47	0.001
Ormocer	RMGIC	0.09	0.087
	Giomer	–0.56	0.001
Giomer	RMGIC	0.47	0.001
	Ormocer	0.56	0.001

Evaluation of Microleakage Test

The following scoring standards were applied to assess microleakage:

- Score 0 = no leakage
- Score 1 = less than or equal to one-half of the cavity preparation's depth
- Score 2 = more than one-half of the cavity preparation, but not including the point where the axial, occlusal, or cervical walls converge
- Score 3 = dye penetration that does not include the axial wall but rather reaches the point where it joins the occlusal or cervical wall
- Score 4 = dye penetration penetrating the axial wall

Statistical Analysis

Statistical analysis was carried out using SPSS® software version 17. ANOVA was one of the tests used to analyze the data, with a significance level of $p < 0.05$. The scores of the three groups were compared using the *post hoc* Tukey's HSD test.

Results

Table 1 shows the comparison of mean microleakage of three different esthetic restorative materials. The least marginal microleakage was found in the ormocer group (1.22 ± 0.01) followed by resin-modified glass ionomer cement group (1.31 ± 0.07) and the giomer group (1.78 ± 0.03). There was a highly statistically significant difference found between the three esthetic restorative materials.

Overall comparisons of mean microleakage of three different restorative materials are depicted in Table 2. There was a highly statistically significant difference found between resin-modified glass ionomer cement group and the ormocer group, resin-modified glass ionomer cement group, and the giomer group.

Table 3: Microleakage scores for the samples used in the present study

	Microleakage scores				
Experimental groups	*Score 0*	*Score 1*	*Score 2*	*Score 3*	*Score 4*
Group I – Resin modified glass ionomer cement	4 (16%)	9 (36%)	11 (44%)	1 (4%)	0
Group II – Ormocer	5 (20%)	10 (40%)	10 (40%)	0	0
Group III – Giomer	2 (8%)	7 (28%)	11 (44%)	5 (20%)	0

There is no significant difference found between the ormocer group and the giomer group.

Resin modified glass ionomer cement group showed a 44% of score 2 and a 36% of score 1 microleakage score. In the ormocer group microleakage score 0 [5 (20%)] was more compared to other groups. In the giomer group, microleakage score 2 was more (44%), and score 1 was 28% (Table 3).

The inference of the present study indicated that ormocer restorative material exhibited superior marginal sealing ability than resin-modified glass ionomer cement and giomer materials.

Discussion

Restorations for primary teeth are different from those for permanent teeth. Because primary teeth have shorter clinical crown heights, they are less able to maintain and sustain intra-coronal restorations properly. Further aspects to take into account for the restorative processes include the larger pulp chambers, the pulp horns closer to the surface, and the large contact surfaces.[8] A sufficient seal between the restoration and the tooth is one of the most important conditions for the restoration's longevity. Bacteria and oral fluids can enter through a weak marginal seal that causes microleakage, potentially leading to secondary caries formation, hypersensitivity, and pulpal pathology.[9]

In this investigation, Class V restorations were selected to assess microleakage. The cervical region of primary teeth has a higher concentration of prism less enamel, which hinders proper bonding. The possibility of microleakage in Class V cavities is influenced by a number of factors, including high C-factor, cyclic flexure, inability to bevel the enamel, and dentin composition and structure.[10]

Following the completion of the restorations, thermocycling was performed on each experimental sample. Thermocycling was used to simulate intraoral variation in temperature. There was no discernible variation in microleakage between 200 and 1,000 thermocycling cycles, according to research by Bertrand et al.[11] Therefore, 500 heat cycles with a dwell duration of 60 seconds at 5 and 55°C and a transit time of 15 seconds were applied to the obtained teeth in the current investigation.

Microleakage studies use dyes; radioactive isotopes, air pressure, bacterial activity, neutron activation analysis, scanning electron microscope, dye penetration, and micro-computed tomography all come with both advantages and drawbacks. The most often utilized method is the dye penetration study of microleakage employing colored agents. The dye penetration assay is superior to other methods in several ways. First, neither radiation nor reactive chemicals are employed. Secondly, the method is quite doable and simple to replicate. Notably, 0.5% basic fuchsin, 2% methylene blue, and 50% silver nitrate are the most often utilized solutions. The method employed in the present study was dye penetration assay. Since methylene blue is easily observable, diffuses through contact, and is not absorbed by dentinal matrix hydroxyapatite crystals, it was chosen as the dye for this study. Its increased penetrability and superior void penetration over isotopes are due to its reduced molecular weight. In order to assess the actual amount of dye leakage, the stereomicroscope was employed in this investigation.[12]

The Ormocer group had the least amount of marginal microleakage, followed by the Resin modified glass ionomer cement group and the Giomer group. These results are consistent with the research conducted by Yazici AR et al.[13] on the microleakage of Class V cavities restored using three distinct types of flowable resin restorative material. They stated that flowable composite was less effective than ormocer. Ormocer is organically modified ceramic. This is a three-dimensional compound polymer made of polymerizable organic units functionalized over an inorganic silicon dioxide substrate. Resin-modified glass ionomer cement is a biocompatible and fluoride-releasing material with enhanced physical qualities, particularly in terms of tensile strength and abrasion resistance, greater wear resistance, good adherence to enamel and dentin, and satisfactory esthetics. Giomers have properties like fluoride release, fluoride recharge, excellent esthetics, and biocompatibility.[7]

According to Hickel R et al.[14] and Jain P[7] less shrinkage means that the adhesive needs to have less adhesion power, and the smaller marginal gap is anticipated over the long term in particular. The structure of the Ormocer group, a biocompatible polysiloxane net with minimal shrinkage even before light curing, may be the likely cause of the decreased microleakage. The process of hydrolyzing and then polycondensing Si $(OR)_3$ groups initiates the creation of the inorganic network.

In the present study, the Giomer group exhibited the highest marginal microleakage in contrast to the Ormocer group and the resin-modified glass ionomer cement group. This result was consistent with the findings of Yadav G et al.[15] stated that the highest amount of microleakage can be attributed to the high filler quantity, as the resin does not bond with the S-PRG filler.

In the present study, the immediate finishing/polishing method used in this study in accordance with the manufacturer's instructions may have contributed to RMGIC's higher microleakage score than the Ormocer group. In addition to surface roughness, Yap AU and Mok BY.[16] have reported that immediate finishing or polishing could compromise the marginal seal of RMGIC to the tooth.

The limitation of the present study included that, since this study was carried out *in vitro* and its findings might not be applicable to clinical settings, a larger sample size and *in vivo* settings should be used to correlate the current findings and provide pertinent information on these restorative materials. An important factor in deciding the success of the restoration is the material's ability to attach to the tooth surface and its solubility in oral fluids. Furthermore, determining the extent of microleakage in an oral environment requires more investigation.

Conclusion

The present study concluded that there was some amount of microleakage in primary teeth in all restorative materials examined in this *in vitro* investigation. However, the marginal sealing ability of ormocer was found highest compared to resin-modified glass ionomer cement and giomer materials.

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