Evaluation of Gingival Microleakage of Colored Compomers in Primary Teeth: an in vitro Study

Original Article

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Abstract

Introdouction:
Microleakage is a major factor affecting the longevity of adhesive restorations. Colored compomer is a new restorative material that was specifically designed for the restoration of primary molars in different colors, but their microleakage is unknown. This study was carried out to compare the microleakage of a colored compomer (Twinky star) and a conventional compomer (F2000) with a microhybride composite (Z250).

Materials and methods:
In this in vitro study, class V cavities were prepared on buccal surfaces of 30 caries free extracted primary molars with gingival margins 1 mm below the Cemento Enamel Junction. The teeth were filled as follow: Group I: single bond2(3M, ESPE, USA) + composite (Z250, 3M); Group II: Solobond M (VOCO, Germany) + colored compomer (Twinky star, VOCO); Group III: single bond2 + compomer (F2000, 3M).After polishing the restorations, all specimens were stored in distilled water for 6 days. Then, the samples were thermocycled for 500 cycles and placed in 0.5% fuchsine solution for 48 hours. The samples were sectioned longitudinally and evaluated for microleakage under a stereomicroscope (MoticMicro Optic, industrial group Co, LTD, Japan) at 40x magnification. Dye penetration was scored on a 0–4 ordinal scale. Data were analyzed using SPSS 14, Kruskal-Wallis, and Mann Whitney ranks tests. The level of significance was set at $P < 0.05$.

Results:
There was no significant difference in the gingival microleakage of Twinky star and Z250 ($P = 0.374$), but the difference was significant between these two materials and F2000 compomer ($P < 0.05$). The most microleakage was observed in F2000 compomer.

Conclusion:
According to this study, due to their relatively low microleakage, special glitter, attractiveness to children, and release of fluoride, colored compomers might be an appropriate restorative material for restoration of primary teeth.

Key words:

•Composite Resins •Compomers •Dental leakage •Primary teeth.

Introduction

As a result of the large number of patient inquiries concerning tooth colored restorations in posterior teeth, use of posterior resin composite material has increased.(1) Maintaining the seal for the margins of adhesive restorations against microleakage is one of the major factors affecting clinical longevity.(2, 3) Prevention of microleakage in the restorations is one of the main purposes in operative dentistry. Microleakage has been defined as the marginal permeability to bacteria at the tooth-material interface. It is the result of a breach in the tooth-restoration interface, which leads to discoloration, recurrent caries, and pulpal inflammation.(2, 4)

Material's ability to seal a cavity preparation can be influenced by its composition, plastic deformation, flow properties, coefficient of thermal expansion, modulus of elasticity, and mechanical stresses caused by type of cavity preparation.(5) Generally, because of the homogenicity of the structure of enamel and lack of dentinal fluid, adhesion to enamel is easily achievable. However, due to the heterogenicity and outward movement of dentinal fluid and its higher organic content, formation of an appropriate bond to dentin is not easy.(6)

Composites are tooth colored materials with appropriate physical and mechanical properties. The major disadvantage of composites is the risk of microleakage due to polymerization shrinkage.

Over the past fifty years, many changes have occurred in structure of restorative materials for children. The fluoride releasing and chemical bonding characteristics of glass ionomer cements are well known. (3, 7) Low abrasion resistance and strength and the esthetics of glass ionomers limit their usage.(8) Compomers were introduced in 1992 and are composed of 20% glass-ionomer cement with 80% visible light polymerized-resin component. They combine the mechanical and esthetic properties of composites with the fluoride releasing advantages of glass-ionomers.(7, 8) Colored compomers can be manufactured by adding a small amount of glossy particles (mainly silicates from kali) to conventional compomers. They are available in the following colors for the restoration of primary molars: pink, green, blue, silver, yellow, or gold. (9) As the child is able to choose their compomer color, this has a positive emotional effect and reduces stress and fear of the treatment.

The microleakage rate of different materials may be useful for a comparative assessment of materials, and the selection of restorative materials with better marginal seal is directly related to the performance and longevity of the restorations.

Cristina et al. compared the marginal leakage of compomer restorations in primary molars and reported different rates of microleakage for two compomers; one compomer showed less microleakage and the other showed more microleakage than a composite.(5) Also, in some studies, researchers achieved similar microleakage between compomers and composites.(10, 11, 12, 13)

There is controversy about of microleakage of conventional compomers. Furthermore, there is little literature available on the subject of microleakage of colored compomers. The aim of the present study was to evaluate and compare the microleakage of Twinky star colored compomer, Z250 composite, and F2000 compomer in class V restoration of primary teeth.

Materials and Methods

The present study is an in vitro experimental study and sampling was done by a simple sampling method.

Thirty primary molars extracted for orthodontic reasons were examined. The study protocol was approved by the Ethics Committee of Babol University of Medical Sciences. A criterion for tooth selection included intact buccal enamel with no cracks and the absence of caries or previous restorations. We used F2000 compomer (3M, ESPE, USA), Z250 composite (3M, ESPE, USA), and Twinky star compomer (VOCO, Germany) to fill the cavities and self-cured transparent acryl (Bayer German) to mount the teeth (Table 1).

Teeth were cleaned with a rubber cup and slurry of pumice and stored in 1% chloramine T solution for 24 hours at room temperature. The teeth were randomly divided into three groups, with 10 teeth in each. The samples were prepared with a 0.8 mm fissure bur (Tizkavan, Tehran, Iran) using a high speed handpiece cooled with an air-water spray. A standardized class V cavity was prepared at the buccal surface of each tooth with no bevel at the margins. Dimensions of the cavities were 3/0mm × 2/0 mm × 1/0 mm (depth).The occlusal margins of cavities were prepared in the enamel, 1 mm up to the Cemento Enamel Junction (CEJ), and gingival margins extending 1 mm below the CEJ. Each bur was used for five samples, and groups were treated by one of the following three methods.

Group I: the prepared surfaces (enamel and dentin) were conditioned with 37% phosphoric acid etchant gel for 15 seconds, thoroughly rinsed for 15 seconds, and blot dried. As mentioned by the manufacturer, single bond 2 (3M, ESPE, USA, 5th generation adhesive system) was applied to the cavity surfaces in two layers with an applicator tip for 15 seconds using mild agitation. The surface was gently air-thinned for three seconds and polymerized with QTH light source (750 mw/cm2; Atralis 7) for 20 seconds. The resin composite (Z250, colorA2) was placed in the preparations in two increments obliquely, and each increment was light-cured for 30 seconds.

Group II: the process was similar to group I, but solobond M (VOCO, Germany, 5thgeneration adhesive system) and silver colored compomer (Twinky star) were used.

Group III: the process was similar to group I, but single bond2 and compomer (F2000, colorA2) were used.Immediately after cavity filling, all the restorations were polished with soflex disks (3M, ESPE, USA) from coarse to soft respectively. All procedures were done by one person. The teeth were stored in distilled water at room temperature for 6 days and then thermocycled for 500 cycles (between 5°C/55°C)

The root apices were sealed with sticky wax, and then two coats of nail varnish were applied to the entire tooth surface within 1 mm of the restoration margins. The specimens were immersed in 0/5% fuchsine dye solution for 48 hours at room temperature. Then, the teeth were retrieved from the dye solution, washed, dried, mounted in acrylic resin, and sectioned buccolingually through the center of the restoration by a cutting machine(Nemov, Mashhad, Iran).During sectioning, water was used for cooling and cleaning debris.

Table 1. Composition of the materials used in this study

Material	Organic matrix	Inorganic filler	Filler content (%wt)	Filler size (Mm)
Single Bond 2	BisGMA, HEMA, dimethacrylate, methacrylate functional copolymer of Poly acrylic and poly itaconic acid, water, alcohol, photoinitiator	spherical silica particles	10	0.05
Solobond M	BisGMA, HEMA, acetone, organic acids, fluoride component	-	-	-
Twinky star	BisGMA, UDMA, TEGDMA, carboxylic acid modified methacrylate, camphorquinone, BHT	Barium aluminum fluorosilicate glass, strontium fluorosilicate glass, silicon dioxide	77.8	0.4–3.0
Filtek Z250	BisGMA, BisEMA UDMA, TEGDMA	zir¬conia, silica	78	0.01– 3.5
F2000	Citric acid dimethacrylate oligomer, TEGDMA,	Silane-treated glass Silane-treated silica	84	3-10

BisGMA: bisphenol A diglycidildimethacrylate
HEMA: Hydroxyethylmethacrylate
UDMA: Urethane dimethacrylate
TEGDMA: Triethylene glycol dimethacrylate
BisEMA: ethoxylated bisphenol A glycol dimethacrylate
BHT: bromohexyl thiophene

The sections were examined at 40x magnification under a stereomicroscope (MoticMicro Optic, industrial group Co, LTD, Japan) twice by one observer.

The degree of gingival microleakage was determined by the criteria described by Khera and Chan[7], as follows:

0: No leakage, 1: leakage up to one-half of the length of the cavity wall, 2: leakage of more than one-half of the length of the cavity wall, 3: leakage along the full length of the cavity wall without including the axial surface, 4: leakage including the axial surface.

The result of the dye penetration test was scored for gingival margins. Data were analyzed using SPSS 14, Kruskal-Wallis, and Mann Whitney ranks tests to determine the significant differences between the groups. The level of significance was set at $P < 0/05$.

Results

In this study, gingival microleakage of colored compomer was evaluated. Comparisons of Total microleakage of gingival margins of primary teeth are shown in Table 2. The Kruskal-Wallis test showed a significant difference between the groups ($P = 0.002$).The data was then analyzed with the Mann-Whitney test.

Twinky star colored compomer and Z250 composite exhibited the lowest degree of marginal microleakage, and there was no significant difference between these two materials ($P = 0.374$).

F2000 compomer showed the highest degree of marginal microleakage, and there was a significant difference between F2000 compomer, Z250 composite ($P = 0.005$), and Twinky star colored compomer ($P = 0.003$).

Table2. Comparison of microleakage scores and Mean ± standard deviation among various restorative materials

Restorative material	Score0	Score 1	Score 2	Score 3	Score 4	Mean± SD	Pvalue (KrusKal Wallis)
F2000	1	2	1	0	6	2.8±1.2	0.002
Twinky star	5	5	0	0	0	0.5± 0.5	
Z250	3	7	0	0	0	0.7 ± 0.4	

Discussion

Compomers are a combination of composite resin and glass ionomer cement. They contain filler and a light curable resin based polymeric matrix. The glass fillers of compomers are partially silanized, providing a bond with the resin matrix. Therefore, compomer materials behave more like composites than glass ionomer cements.[12] Polymerization shrinkage of composite resin is a major problem. It results in volumetric contraction, causing stresses in bonded restorations that can lead to deformation of the cusps, enamel microcracks, decrease of marginal adaptation, and postoperative sensitivity.[13] Marginal leakage may be created by dimensional changes or lack of adaptation of the restorative materials to the cavity walls, leading to recurrent caries and pulp inflammation. One of the measures for assessing the marginal adaptation of the composite restorations is microleakage. Several methods have been presented for measuring the microleakage. In this study, the dye penetration technique was used because it is the most common technique for assessing microleakage and does not require complex laboratory equipment.[3, 14] Researchers suggest that the dye used in this method should have particle sizes smaller than or equal to the size of bacteria (about 2 microns), such as 2% methylene blue solution.[10] We used a stereomicroscope to evaluate the rate of microleakage, according to the depth of color penetration at the restoration-tooth interface.

In this study, samples were thermocycled. Thermal cycling is commonly used in dye penetration tests of dental materials. Temperatures of 5°C and 55°C simulate changes in temperature in the oral cavity (in vivo).

The results showed that none of the three filling materials were free from microleakage. In this study, the highest microleakage was observed in F2000 compomer restorations, and there was no significant difference in microleakage between Twinky star and Filtek Z250.

However the difference between F2000 and the two others was significant. These findings are in accordance with the findings of other studies.[5,15] In the study of Cleide Cristina et al.

on the rate of microleakage in poly acid-modified resin composite restorations in primary teeth, the rate of microleakage between Filtek Z250 composite and Dyract AP compomer was similar, but in F2000 compomer, the rate was higher.[5] The magnitude of polymerization shrinkage is dependent on the extent of the reaction, the stiffness of the material, and its ability to flow. Higher filler loading of composites results in a higher degree of stiffness, which ultimately causes high shrinkage stress.[15, 16] F2000 contains 84wt. % inorganic fillers and monomers with high molecular weight such as citric acid dimethacrylate (CDMA).The CDMA oligomer is a dimethacrylate functional oligomer derived from citric acid, and it has many methacrylate groups which allow greater cross-linking of the resin matrix. This process is possibly related to a limit of stress relief by flow, resulting in high internal stress build-up and following more microleakage in F2000 compomer.[12]

Also, in this study, polishing was performed directly after restoration. According to previous studies, immediate polishing of compomers yields a significant decrease in bonding strength and increase in the rate of microleakage, whereas the time of polishing does not have any effect on the bonding strength of composites.[17, 18, 19]

In this study, the microleakage of Twinky star compomer and Z250 composite was not significantly different. According to Hwang et al., the transmission of light through a material is influenced by the color of the samples.[20] It was observed that lighter shades of resin-based materials cured to a greater depth than darker shades due to the scattering of light in the materials, based on their particle size, amount, and the type of filler particles.[20, 21, 22] A higher transmittance leads to a greater delivery of light inside and at the bottom of the sample, without loss of intensity by absorption.[23] Colored samples such as colored compomers had lower transmittance. It seems that since glitter particles had higher absorbance, the irradiated curing light had less chance to be fully delivered to the bottom of the sample.[22] Therefore, in colored compomers, the degree of polymerization can be lower because of absorption of the curing light by the colored particles.[24] When the degree of polymerization decreases, the polymerization shrinkage and subsequent microleakage also decrease. This may be a reason for the lower microleakage in the colored compomer compared to F2000.

Expansion due to water absorption is one of the reasons that there is also a decrease in microleakage in compomers.[14, 25] Polymerization is associated with contraction and the development of stress, and water sorption may play a role in reducing these stresses. McCabe et al. evaluated water sorption of some materials and observed that it is different in each compomer.[26]

The presence of the silanated fillers in F2000 reduces water sorption and expansion, unlike in the Twinky star.[27] Due to different compositions, it is possible that water absorption in the Twinky star colored compomer is higher than F2000 compomer, and therefore it should be further studied.

The present study encountered some limitations. The dye penetration method has been suspected to lead to the overestimation of microleakage and false positive results because of very small dye molecules.[28] Thus, another method, such as bacterial leakage, is recommended to verify the results of this research. In addition, occlusal loading has been shown to be effective in microleakage rates and bond strengths, its effects require further investigation.

Conclusion

Considering the lower degree of microleakage of Twinky star colored compomer compared to F2000 compomer, and the lack of significant differences to Z250 composite, colored compomers, due to their special glitter effect and attractiveness to children and their release of fluoride, might be an appropriate restorative material for the restoration of primary teeth.

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