MARGINAL LEAKAGE EVALUATION OF GIOMER AND COMPOMER IN PRIMARY TEETH (IN-VITRO STUDY)

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ABSTRACT

INTRODUCTION: Although many restorative materials are available in the market, microleakage around dental restorative materials presents a major problem in clinical dentistry. Giomer (Beautifill II) represents a new generation of dental materials that combines the properties of glass ionomers and composites.

OBJECTIVES: The aim of this study was to evaluate the marginal leakage in primary molars class II restored with Giomer and compare it to that of Compomer.

MATERIALS AND METHODS: Twenty-four extracted sound primary molars (n=24) were selected for micro leakage test. Standardized class II cavities were prepared and the teeth were randomly assigned to two groups (n=12). Group I was restored with the Giomer (Beautiful II) and Group II was restored with Compomer (Dyract). Micro leakage test: Teeth were subjected to the process of thermocycling (5 ± 2°C–55 ± 2°C, dwell time 30 s, 1000×). Teeth surfaces were coated with three layers of nail polish except a 1 mm wide window surrounding the margins of the restorations. The restored teeth were immersed in 2% methylene blue solution, sectioned and examined under stereomicroscope. Data were collected, tabulated and statistically analyzed using Mann-Whitney test and Wilcoxon Signed Ranks test ($p<0.05$).

RESULTS: Cervical microleakage scores were higher than occlusal microleakage scores with no significant difference in group I (Giomer) ($p=0.915$). In group II (Compomer) cervical microleakage scores were significantly higher than occlusal microleakage scores ($p=0.033$). Group I showed lower microleakage scores than group II and the difference was statistically nonsignificant at p value (0.155).

CONCLUSIONS: Although no significant difference was detected, Giomer restorative material showed lower microleakage scores than Compomer. Giomer restorative material could be considered a suitable class II restoration of primary molar in high caries risk children.

KEYWORDS: Giomers, Compomer, class II, microleakage, primary teeth.

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INTRODUCTION

Dental caries remains the single most common disease of childhood. Various campaigns have been carried out to promote and improve the oral health of children. However, the prevalence of dental caries is still more than 50% in many communities (1).

Primary teeth are vital to the child development and every effort should be made to retain these teeth for as long as possible. With an ultimate goal to restore teeth form and function, restorations continuously developed to repair these damaged teeth (2). There is an increasing demand for materials to resemble the natural tooth and seal the exposed tooth structure from the oral environment (3). The quality and durability of the marginal seal are of major importance for the longevity of restorations (4,5).

There is a continuous and fairly rapid turnover in restorative and adhesive materials to improve their formulations and mechanical properties. One of the hybrid materials is Compomer, which is a polyacid modified composite resins. It provides combined advantages of composites and glass ionomer, which are ease of handling, placement and polishing with optimal esthetics. It requires no mixing and have higher bond strength than glass ionomers. Its fluoride release is greater than composites but less than glass ionomers. Disadvantages of Compomer include that it is technique sensitive, limited fluoride release, expansion of matrix due to water sorption and the decrease of physical properties with time (6).

Recently, a new category coined as "Giomer" has emerged. Giomer is a tooth-colored restorative material that uses a resin base and pre-reacted glass ionomer (PRG) technology. The PRG filler is made by the reaction of the acid reactive glass containing the fluoride with polyalkenoic acid in water before being incorporated into the resin materials. Two types of PRG filler technology are available: surface-reacted PRG filler (S-PRG filler) technology and fully reacted PRG filler (F-PRG filler) technology. The second generation Giomer is composed of the S-PRG filler that avoided water absorption tendency and expansion that was reported in restorations of first generation Giomer composed of the F-PRG filler (7).

S-PRG technology provides properties of glass ionomer as fluoride release and fluoride recharging characteristics claimed to be more effective than other resin matrix materials, thus preventing caries recurrence. It also has properties of resin composite providing excellent aesthetics, easy polish ability, biocompatibility and better surface finish. Moreover, it has an antiplaque effect through forming a material film layer by saliva that is reported to minimize plaque adhesion and inhibit bacterial colonization (7, 8). Giomer reported comparable microleakage scores to that of composite in permanent teeth (9).

Beautifil II, a second generation of Giomer, has been the subject of few experimental studies when used in primary teeth and most of these studies were conducted to examine their mechanical properties. This scientific gap set off the present study to assess the microleakage of Beautifil II against another conventional material to seal off its performance as an

optimal material for class II cavities in primary teeth. Based on the available data, the proposed research hypothesis was that Giomer would show lower microleakage scores in comparison to Compomer when used to restore class II cavities in primary teeth.

MATERIALS AND METHODS

The present in vitro study was carried out in the Departments of Pediatric Dentistry and Dental Public Health and Dental Biomaterials, Alexandria University after the approval of the Ethics Committee.

The estimated sample size was 12 teeth per group using alpha error =0.05, effect size = o.96 at a power 80%. The study sample included 24 non carious second primary molars extracted for the reason of over-retention or near their time of exfoliation. Teeth should be free of enamel cracks or surface defects that was verified by magnifying lens. Surface debridement of all the teeth was done with hand instruments and the teeth were stored in distilled water with 1% chloramines at room temperature till further use (10). Teeth were randomly divided into two groups (12 teeth each). Group I was restored with the Giomer (Beautifil II,Shofu, Kyoto, Japan) and Group II was restored with Compomer (Dyract, Caulk/DENTSPLY).

Proximal boxes were prepared using #330 carbide burs at high speed with air/water cooled hand piece. The burs were replaced every four preparations (11). The occlusal part of the proximal preparation was limited to the triangular fossa. The proximal box width extended from the central groove a distance equal to one bur diameter to the buccal and one bur diameter to the lingual. The depth of the box was 3mm in height occluso-cervically. The mesiodistal width of the gingival seat was approximately 1mm. For standardization purpose, a K-file and a millimeter ruler were used to measure the dimensions of the cavity (12). Prepared cavities were then thoroughly cleaned with water and gently dried before the placement of the restoration.

In each group the cavity was restored with its assigned restorative material according to the manufacturer's instructions. (Table I)

The teeth were thermocycled in a water bath for 1000 cycles using the thermocycling machine, alternating between 5°C and 55°C with a dwell time 30 seconds. The specimens were then prepared for dye exposure. Teeth surfaces were coated with three layers of nail polish except a 1 mm wide window surrounding the margins of the restorations. The pulp chamber, root apices and furcations of the teeth were occluded with modeling wax to prevent leakage through them. The teeth were then immersed in 2% methylene blue solution in dark closed bottles for 24 hours to prevent dye loss and drying (13). Teeth were then rinsed thoroughly under running water for half an hour and sectioned longitudinally through the center of the restoration in a mesiodistal direction using a water-cooled low-speed diamond saw (13). Sectioning resulted in two approximately equal par

The two cut surfaces of each sectioned tooth were viewed under light stereomicroscope at a magnification of x20. The extents of dye penetration at the occlusal and cervical margins of the restorations were assessed according to the scoring system described by Radhika et al (2010) (14). (Table II) The highest amount of microleakage occlusally and cervically was recorded as the scores of the restoration. The intraexaminar reliability was assessed using kappa statistic was 0.876.

Table I: Composition of the restorative materials tested in this study.

Materials	Manufacture	Chemical composition
Giomer (Beautifil II)	Shofu, Kyoto, Japan	Matrix: Base resin (Bis-GMA and TEGDMA) Filler structure surface pre- reacted flouroboroaluminosilicate glass filler Filler loading : 68.6 vol% and 83.3 wt% Range of particle size : 0.01-4um Average particle size : o.8um
Fluoride releasing dental bonding system (FL Bond II)	Shofu, Kyoto, Japan	**The primer** is acetone free adhesion promoting monomer with no incorporation of HEMA. Contains ethanol, methacrylic adhesive monomer , pure water and 4-AET(4-Acryloxyethyltrimllitic acid) **The bonding agent :** contains S-PRG filler and hydroxyl ethyl methacrylate ,UDMA and TEGDMA
Compomer (DYRACT)	Caulk/DENTSPLY	urethan dimethacrylate (UDMA) ,Tetracarboxylic acid-hydroxyethylmethacrylate-ester (TCB Resin),alkanoyl-poly-methacrylate ,strontium-fluoro-silicate glass ,strontium floride, butyl hydroxyl tolueontium fluoride , photo initiator ,butyl hydroxyl toluene , Iron oxide pigments
Caulk® 34% Tooth Conditioner Gel	Caulk/DENTSPLY	Water, 34% Phosphoric acid, Silicon Dioxide, Surfactants, Blue Colorant.
Prime & bond NT	Caulk/DENTSPLY	DI-andTrimethacrylate resins, PENTA (dipentaerythritol penta acrylate monophosphate), photoinitiators, stabilisers , cetylamine hydrofluoride , acetone, functionalized amorphous silica

Table 2: Comparison between combined occlusal and cervical microleakage scores of the two studied groups**.**

	Sample	combined Microleakage scores	
		Giomer group	Compomer group
Occlusal margin	1	0	0
	2	1	1
	3	0	0
	4	0	1
	5	2	0
	6	0	0
	7	1	3
	8	0	0
	9	0	3
	10	1	0
	11	0	0
	12	2	0
Cervical margin	1	0	0
	2	2	1
	3	0	2
	4	0	3
	5	0	0
	6	2	2
	7	1	3
	8	1	3
	9	0	2
	10	2	0
	11	0	3
	12	0	1
Minimum		0	0
Maximum		2	3
Median		0	1
Mann-Whitney U test		Z=1.424 p=0.155 NS	

Z: Z for Mann Whitney U test
NS: Not statistically significant

RESULTS

Cervical microleakage scores were higher than occlusal microleakage scores in both groups. In group I (Giomer group) the scores ranged between 0 to 2. There was no statistically significant difference between the median of the occlusal and cervical microleakage scores with p value equals 0.915 (Z=0.107) (Fig. 1).

In group II (Compomer group), the scores ranged between 0 to3. Wilcoxon signed ranks test showed statistically significant difference between the median of occlusal and cervical microleakage scores with p value = (0.033), (Z = 2.136) (Fig. 2).

No statistically significant difference between the combined occlusal and cervical microleakage scores of the two study groups was found with p value = (0.155) (Z=1.424) (Table III). However, Giomer restorations showed less microleakage scores than that of Compomer restorations

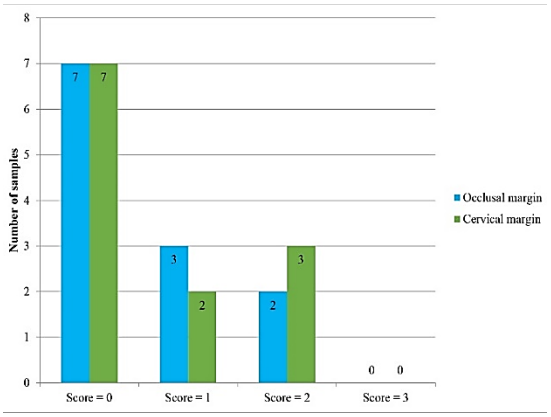

Figure 1: Bar graph representing the occlusal and cervical microleakage scores in group I (Giomer).

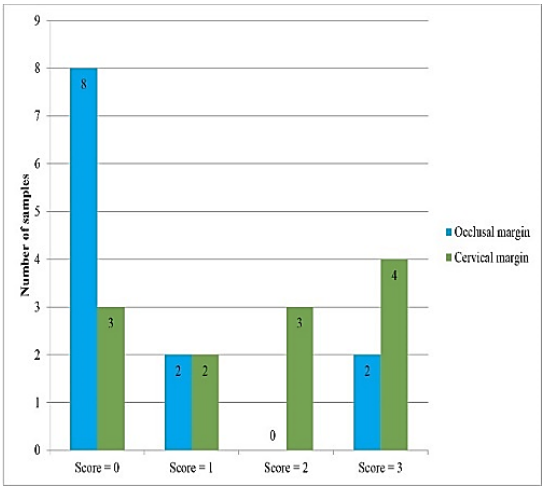

Figure 2: Bar graph representing the occlusal and cervical microleakage scores in group II (Compomer)

DISCUSSION

Microleakage between cavity wall and restorative material is one of the main causes of marginal discoloration, secondary caries, postoperative sensitivity, restoration failure, pulpal pathology and loss of restoration (15, 16). The purpose of this study was to evaluate the microleakage of the second generation Giomer (Beautifil II) used as a class II restorative material in primary molars compared to Compomer (Dyract).

Class II cavity preparation was considered the appropriate cavity preparation for testing Beautifil II in-vitro microleakage. It presents a challenging area for any restorative material as the orientation of the dentinal tubules can negatively affect the quality of hybridization, which favors leakage in resin-based restorations placed in interproximal boxes (17).

Laboratory studies have shown that phosphoric acid etching reduce microleakage (18) and improve the bond strength of Compomers (19), in return, additional acid etching with 34% phosphoric acid prior to application of dentin bonding agent in group II (Compomer) was done according to manufacturer recommendations. In group I (Giomer) cavity conditioning was done using the two steps self-etch primer (FL-Bond II). Research has reported that pre-treatment with phosphoric acid had little effect on improving enamel bonding effectiveness with most self-etch primers (20). Dentin etching with phosphoric acid prior to using mild self-etch primers was reported to negatively affect dentin bonding (20, 21). This approach may be responsible for the formation of an incomplete infiltration of the resin monomer through the over-etched dentinal surfaces. Accordingly, pre-treatment with phosphoric acid prior to the application of self-etch primer in group I was eliminated.

The difference in the coefficient of thermal expansion of the restoration and the tooth with the resulting mismatch may cause fatigue of the bond between the restoration and the tooth interface leading to a gap formation, and subsequent microleakage (22). Therefore, the samples were subjected to thermocycling in order to simulate the intraoral condition. In the current study all specimens were subjected to 1000 cycles between 5° C and 55° C with dwell time 30 seconds which is considered an appropriate artificial aging test as it is equivalent to 12 months of clinical service (23).

The dye leakage method was used in the present study to detect microleakage because it is simple, inexpensive and does not require the use of complex laboratory equipment (24,25).

The statistical analysis of the occlusal and cervical microleakage scores in group I (Giomer) revealed no significant difference. This finding is in agreement with Deliperi et al (2006) (26) who found no significant differences between the occlusal and cervical microleakage scores when they used Giomer in class V permanent molars and premolars. On the other hand, comparing between the occlusal and the cervical microleakage scores in group II (Compomer) there was a statistically significant difference in favor of the cervical margin. This finding is in agreement with Rekha et al (2012) (27) and Yeolekar et al (2015) (27) who tested the microleakage of Compomer in class II cavity preparation in primary teeth. They showed that gingival microleakage scores were higher than occlusal microleakage scores. Comparable results were obtained by Aysegül et al (2005) (29) who assessed the degree of marginal leakage of a Compomer in Class V cavities of human primary molars. They claimed that enamel margins provided better marginal sealing than dentin/cementum margins. This finding is also in agreement that of Shruthi et al (2015) (30) who tested Compomer microleakage in class V cavity preparation in primary teeth. They showed that Compomers exhibited microleakage at cervical margins more than the occlusal margins.

On the contrary Roebuck et al (2001) (31) found no significant difference between occlusal and cervical margin in permanent teeth restored using Compomer. This contradictory result might be due to the fact that the peritubular dentin of primary teeth is 2–5 times thicker than that of permanent teeth, with thicker peritubular dentin and relatively less intertubular dentin. Since intertubular dentin is the major area where bond occurs, primary teeth provide lesser bonding and more microleakage compared to the permanent teeth. According to Rontani et al (2000) (32) acid acts differently on primary teeth because of differences in the microstructure of primary and permanent teeth.

The results obtained in the present study showed that both restorative materials exhibited more microleakage at the cervical margins than at the occlusal margins. This may be attributed to a combination of factors such as the decreasthe number and the thickness of enamel rods cervically, poor adherence of the material at the cervical margin and the presence of cracks at the cervical margin (31).

The present data showed no statistically significant difference between the combined occlusal and cervical microleakage score values of the two tested materials. However, the least microleakage occurred in the Giomer group. It effectively prevented the ingress of dye substance to the dentin pulp complex as compared to group II, probably due to its adequate bond strengths in addition to the physical and mechanical properties of the material. This is in agreement with the results obtained by Sengul et al (2015) (33) who reported that Giomer performed clinically better than Compomer in class II cavity. The better seal seen with Giomer even when using FL- bond which is considered a mild

self –etch primer can be explained by the fact that nano-retentive interlocking is created between enamel and resin resulting in increased bonding effectiveness through micromechanical and chemical interaction with tooth substrate. The chemical component may be able to compensate for the decreased micromechanical interlocking (34, 35). The FL-Bond system contains 4-AET (4-Acryloxyethyltrimellitic acid), which can interact with the calcium cations of hydroxyapatite to form 4-AETCa, a relatively insoluble calcium salt that improves durability of the adhesive system as stated by Ikemura (2002) (36). Contradictory results to the present study have been reported by Yadav et al (2012) (37). They reported that microleakage was significantly higher with Giomer than with Compomer. This disagreement might be the result of using different type of Compomer (colored Compomer), which is characterized by the unique dual cure feature as well as using class I cavity preparation unlike the present study.

Although every effort was made to simulate the clinical situation, e.g, using extracted human molars and thermocycling to mimic the hot and cold changes, the in vitro studies still cannot mimic the human oral environment completely. In vitro data can exaggerate bonding capabilities due to a well- controlled experimental environment. In the present study, restorative materials were placed in class II cavities prepared using a carbide bur on extracted caries- free molars. Clinically, most of class II restorations are placed in cavities prepared in carious teeth. Enamel/dentin bonding characteristics in a pathological situation may be different from the bonding substrates encountered in the in vitro study. Accordingly, Pashley (1990)(38) claimed that the results of an in vitro microleakage study should be viewed as a theoretical maximum level of leakage more than that may be expected in vivo.

Based on the previous data, the tested hypothesis can be rejected as no significant difference was detected between the tested materials. However, when considering the multiple advantages of Giomer regarding its fluoride release, biocompatibility and availability to use in a variety of clinical scenarios, Giomer restorative material can be considered an effective restorative material in primary molar

CONCLUSIONS

Within the limitations of the present study it may be concluded that although no significant difference was detected, Giomer restorative material showed lower microleakage scores than Compomer. Giomer restorative material could be considered a suitable class II restoration of primary molar in high caries risk children.

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest

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