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Effectiveness of mixing procedure on the microleakge of glass ionomer cement as filling material in primary molars (in vitro study)

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Key words
Glass ionomer cement restorative material, Microleakage

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Abstract

Background: Well-adapted restorations with adequate marginal sealing are of extreme importance for the success of atraumatic restorative treatment, The present study was carried out to find if the mixing procedure affect the marginal seal of hand mixed and capsulated glass-ionomer in Class I cavities of 30 non carious primary molars.

Materials and Methods:
Standardized Class I cavity preparations were prepared in 30 extracted sound primary molars. The teeth were then randomly divided into two groups: Group I: filled with mechanically mixed (capsulated) glass ionomer cement (GIC). Group II: filled with hand mixed glass ionomer . After that the teeth were subjected to 250 thermal cycles with a 15 second dwell time in each, then sectioned to be examined under the stereo microscope.

Results:
The sealing ability of the GIC filling materials was determined by their ability to inhibit dye penetration. Data were analyzed according to t-test. The hand mixed GIC provides a better seal than capsulated GIC, there were no significant differences between the two studied groups in their resistance to dye penetration. **Conclusion:** Hand mixed GIC presented a better performance regarding microleakage in comparison to capsulated GIC.

Introduction

In pediatric dentistry, restoring carious teeth is one of the major treatment needs. The ideal requisites for a restorative material are that it should have good colour stability, good biocompatibility, have a co-efficient of thermal expansion similar to that of natural tooth structure, excellent marginal seal, capable of forming strong chemical bonds to enamel and dentin .[1]

A restoration in the primary dentition is different from a restoration in the permanent dentition due to the limited lifespan of the teeth and the lower biting forces of children. As early as 1977, it was suggested that glass ionomer cements (GIC) could offer particular advantages as restorative materials in the primary dentition, and considered as a clinically attractive dental materials that have certain unique properties that make them useful as restorative and luting materials. This includes adhesion to moist tooth structures and base metals, esthetically more attractive than metallic restoration ,

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minimal cavity preparation requirement, chemical adhesion to mineralized tissue, thermal compatibility with tooth enamel, biocompatibility and low toxicity, in addition , by incorporating fluorine, they exhibit an anticariogenic potential[2,3]. Also, because, they only require a short time to fill the cavity, glass ionomer cements present an additional advantage when treating young children.[4]

The glass ionomers are offered by manufacturers in both, hand mixed as well as premeasured capsules, which obviates uncertainties in powder-liquid proportion and allows for a more consistent mix of cements[5].

Microleakage of oral fluids and microbial components is a dynamic phenomenon occurring at the tooth-restoration interface[6], this microleakage may promote tooth discoloration, staining of restorative margins, may be the precursor of secondary caries, an adverse pulpal response and necrosis ,and even hasten the breakdown of certain filling materials . Different restorative materials show different values of microleakage depending upon their composition, setting reaction and nature of physical and/ or chemical bonds with the dental tissue [7,8]. The objective of this study was to find if the mixing procedure affect the marginal seal of hand mixed and capsulated glass ionomer restorative material.

Material and Methods

This study was carried out in the Department of pediatric Dentistry/ Al-Mustansyria University (sample collection), while teeth sectioning and examination was at the department of histopathology/College of Dentistry, Baghdad University.

Sample size was 30 non-carious primary molars which were extracted for the reasons of over retention and selected for this study. The extracted teeth were cleaned of soft tissue and debris, washed under tap water and stored in normal saline at room temperature till further use. Teeth were randomly divided into two groups of 15 teeth each. Standard class I cavities were prepared on all the teeth with no mechanical retention using No.57 straight fissure bur and contra angle high speed air motor hand piece with water coolant, the depth of the cavity was standardized at 1.5 mm with the help of a premeasured and marked No. 57 straight fissure bur. In each group the cavity was restored with its respective restorative material according to the manufacture instructions [9].

Group I the cavities were filled with capsulated glass ionomer restorative material (riva self cure –SDI)

Group II cavities were filled with manually mixed glass ionomer restorative material (riva self cure –SDI)

Then all the teeth were thermocycled at a temperature between 5C° and 55C° through water baths for 250 cycles with a 15 second dwell time in each. All the tooth surfaces, except the restoration and 2mm to its margins were covered with two coats of nail vanish. The teeth were then immersed into 0.5% methylene blue dye for 12 hours at room temperature [10]. After removal from dye solution the teeth were thoroughly washed in water, dried, and were mounted on self -curing acrylic resin blocks. The teeth were sectioned buccolingually by using hard tissue microtome through the center of the restoration [11].

The teeth were then studied under a stereomicroscope to assess the depth of the dye penetration at the margins of the restoration, and the section showing the maximum degree of dye penetration was chosen for grading the degree of microleakage. The extent of the microleakage was noted proportionate to the penetration of dye between the tooth structure and the restoration, separately for enamel, dentin and pulp, and scored using the scoring criteria[9] given below:.

Score 0: No dye penetration

Score 1: Dye penetration between the restoration and the tooth into enamel only.

Score 2: Dye penetration between the restoration and the tooth in enamel and dentin.

Score 3: Dye penetration between the restoration and the tooth into the pulp chamber.

The scores were tabulated, interpreted, and the resultant findings were statistically analyzed using student T- test to find any statistical significant differences among the studied groups.

Results

Table (1) summarizes the leakage scores with its percentage observed for each group of restorations. Of the fifteen teeth filled with capsulated GIC (group I), three teeth showed no dye penetration (score 0, figure 2) with percentage 0f (20%) which is lower than teeth (Six teeth) filled with hand mixed GIC (group II) with percentage of (40%). Concerning score 1 (figure 3) the higher percentage of dye leakage was found in group I (40%), score 2 (figure 4) had an equal results, and finally score 3 (figure 5) the percentage was also higher in group I (20%) when comparing it with that of group II (13.33).

The capsulated glass ionomer cement (Group I) showed in table (2) higher value of mean score of dye penetration (4.00±1.37) than hand mixed GIC (Group II) (3.00±1.0). This result was statistically not significant ($t = 0.87$; $P > 0.05$).

Figure (1) displays that the maximum percentage of dye microleakage score was observed in teeth filled with capsulated GIC score 1 (40%) then followed by hand mixed GIC (26.67) for the same score.

Discussion

The lack of suitable adhesion to the tooth structure and microleakage between the tooth and the filling material is considered to be one of the main problems in adhesive restoration, as longevity of the restoration and stability of treatment is the most important factor in the success, and is largely determined by marginal sealing of the cavity [12,13].

Microleakage is one of the measures for assessing the marginal adaptation of the restoration, that caused by the gap in the interface of restoration and tooth structure and may lead to recurrent caries and pulp inflammation [14,15] . It is well known that a few clinical events may enhance it (such as successive dimensional changes of the material caused by sudden temperature changes, mechanical occlusal stress and hygroscopic alterations), whereas other events may decrease it (such as the maturation of the restorative material or prolonged exposure to saliva, causing obliteration of the space between the tooth and the restorative material through the deposition of mineral salts) on a long-term basis [16].

Class I restorations were thought to be more practical for this microleakage study, as the occlusal surface of primary molars are considered to be one of the susceptible surfaces for caries , and the occlusal cavities could be easily standardized[9].

A large variety of methods have been described to compare the sealing efficiency of restorative systems. Dye penetration tests are usually used because they are generally simple and fast methods [17], and methylene blue solution most commonly used because it can penetrate better than other solutions due to its size that is smaller than the smallest bacteria. On the other hand, it is inexpensive, and easy handling[18].

Our observations revealed that although both procedures (hand mixed and capsulated GIC) leaked to some extent, this leakage was likely the result of gaps created from shrinkage of the material during polymerization, with the amount of shrinkage directly related to the adhesion of the material to the tooth [19], On the other hand, considering that some samples showed no microleakage, the materials are actually capable of reducing bacterial penetration. .

The present study utilized thermal cycling procedure to simulate intra-oral conditions. The temperature range of 55± 2 and 5± 2 used in this study corresponds to the extremes of temperatures that could be experienced in the oral environment [20,21].

Alperstein, et al. [22](1983) and Yap, et al.[23] (2000) have demonstrated considerable microleakage in GIC restorations even when samples were not submitted to thermocycling, which is known to increase microleakage values as it contribute to the dislodgement of the restoration from the cavity walls as a result of contraction and expansion of the tooth and the restoration and because they have different co-efficient of thermal expansion, the adhesion between them may be broken[24]. This fact raises the question of what factors other than adhesive capacity and dimensional stability account for adequate initial marginal sealing.

The other reason for differences in microleakage observed between the tested materials might be due to differences in setting times. A very short solidification time may not allow an appropriate flow of GIC to the cavity bottom and may therefore disturb the marginal sealing of the restoration. In the present study, GIC with a shorter setting time presented higher values of microleakage than GIC with a slower setting time (setting time according to the manufacturer's information of the used company (riva self cure –SDI): hand mixed: 6 minutes, capsulated:4.10 min), this come in agreement with the results of Ferreira et al[25], who demonstrate that the reduced setting times of the imported materials, especially the encapsulated form, may have disturbed the approprniate GIC / dental surface adaptation . On the other hand, a slow rate of the GIC setting reaction is one of the problems associated to clinical use.

This study showed that there was no statistically significant difference in microleakage between the two groups, this may be due to the fact that both materials have low shrinkage, capable of forming strong bonds to dental structure [26].

Despite the many limitations presented by the *in vitro* studies failing to precisely reproduce clinical conditions, they are still considered very useful for indicating directions in the properties of new materials. However, attention should be drawn to the fact that laboratory studies with small sample sizes in carefully controlled and standardized environments, such as the conditions reproduced in this study, should not be extrapolated to more complex clinical situations. This makes it of paramount importance to pursue further clinical studies in order to compare *in vitro* test results with the clinical performance of materials.

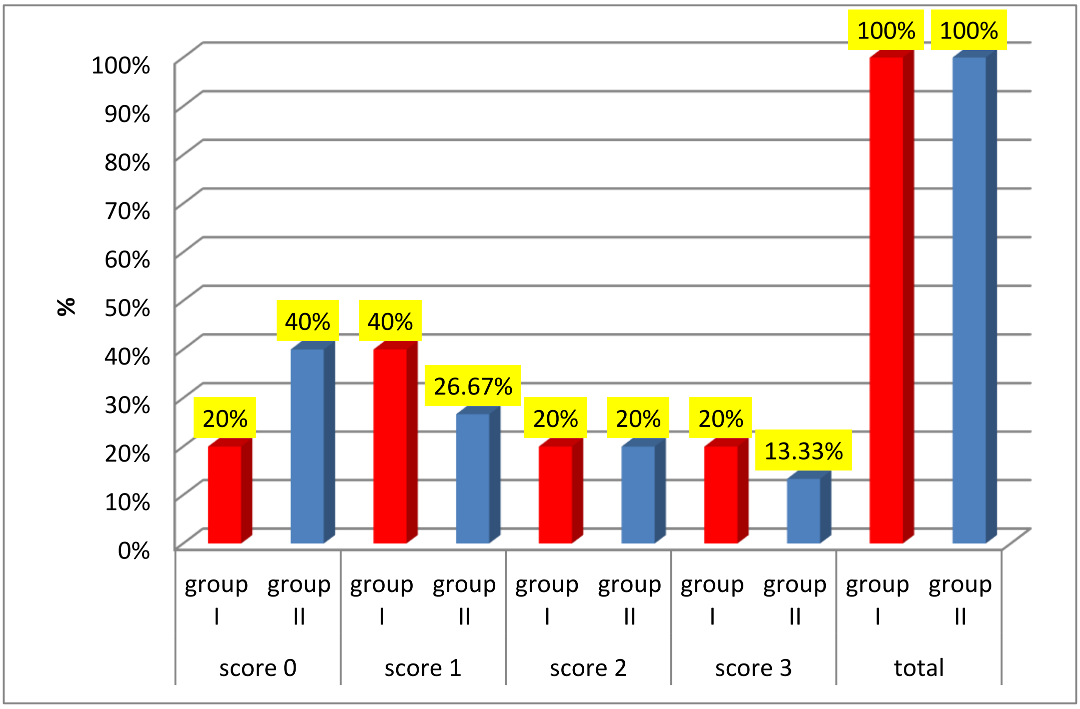

Figure (1) Comparison of dye penetration between the two studied groups

Table (1) Percentage for score of dye penetration of the two studied groups

Microleakage scores	Groups			
	I		II	
	No.	%	No.	%
0	3	20.0	6	40.0
1	6	40.0	4	26.67
2	3	20.0	3	20.0
3	3	20.0	2	13.33
Total	15	100	15	100

Table (2) Dye penetration score (Mean ±SD) for the two groups

Group	Mean	±SD	T	Sig
I	4.00	1.37	0.87	0.45 NS
II	3.00	1.0		

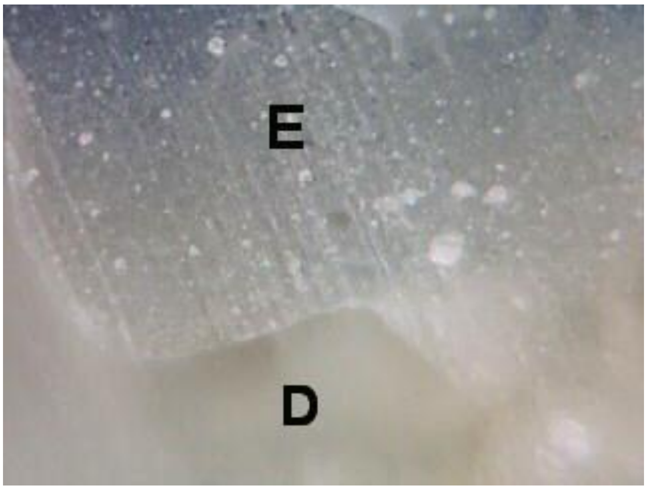

Figure (2) Clear view with no penetration of dye to enamel (E) and dentin (D) ground section X1000 (score 0)

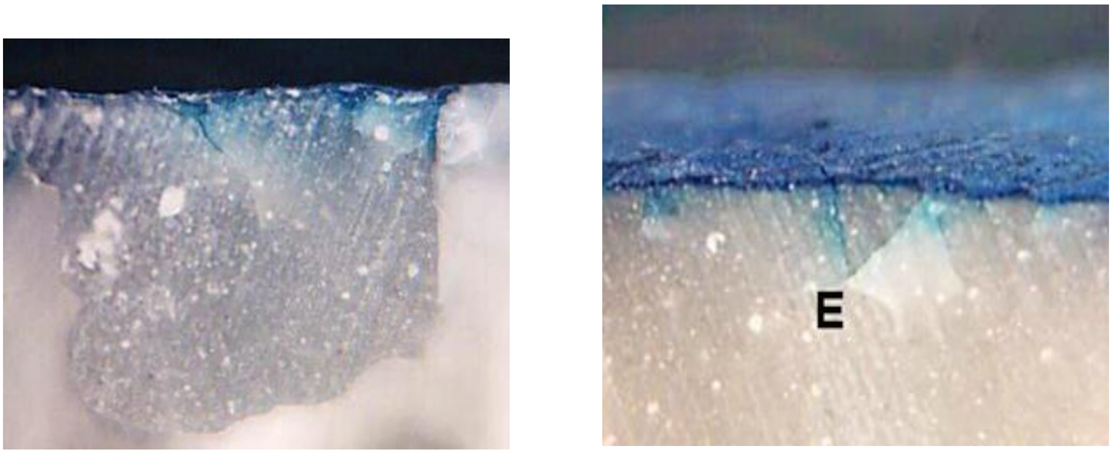

Figure (3) ground section of the tooth shows enamel (E) illustrates positive color dye, ground section X 1000 (score 1).

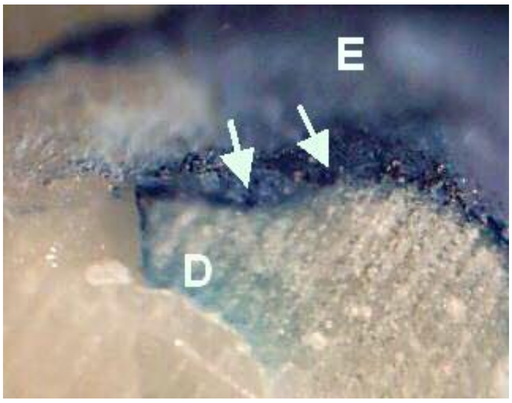

Figure (4) Photographic view for tooth shows penetration of dye to enamel (E), dentin (D) and dentinoenamel junction (arrow) (score 2)

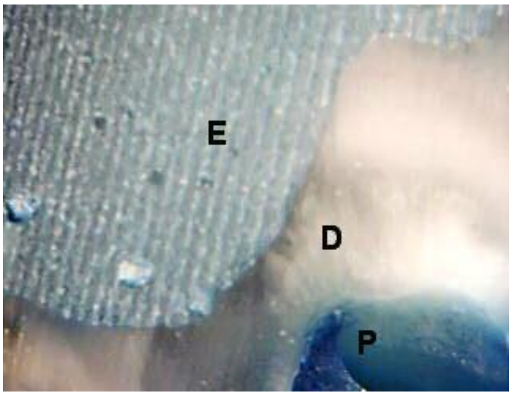

Figure (5) Penetration for dye in enamel, dentin and pulp (score 3)

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