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# Microleakage of Glass Ionomer/composite restoration in Class II cavity in primary molars

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## Abstract

**Aim**: To compare gingival marginal microleakage at the tooth structure / composite resin interface *(closed sandwich technique)* and tooth structure / glass ionomer interface *(open sandwich technique).*

**Method:** forty-five exfoliated sound human primary molars extracted at time of shedding were selected. Class II cavity was prepared in each tooth. The teeth were randomly divided into three equal groups according to the restoration procedure, each group contained fifteen teeth; Group (I) open Sandwich Technique, Group (II) Closed Sandwich Technique, and Group (III) Open Sandwich Technique without etching. All specimens were stored in artificial saliva for one week before thermocycling Microleakage at the gingival margin between the tooth structure and both glass ionomer liner and composite resin was assessed for the extent of dye penetration.

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**Results**: In group (I); 66.7% of the samples had score 0 (no microleakage) 20% had scores 1 and 20% had score 3 and no sample had score 2. In group (II); 86.7% of the samples had a score of 0 (no microleakage) 20% had a score of 1 and 13.3% of the samples had score 2. No samples had a score of 3 or 4. In group (III); No leakage (score 0) was detected in 60% of the samples while score "1" and score "2" microleakage were observed in 20%. Score "3" and score "4" dye penetration were not evident in any samples of group (III).

**Conclusion:** there was no significant difference between different groups. However, microleakage scores were lower in the open than in the closed sandwich technique. In addition, acid-etching on the glass ionomer liner did not eliminate microleakage.

## Introduction

Dental materials often struggle to form a strong bond with tooth structure, leading to imperfect seals. This allows solutes, solvents, and bacteria to penetrate, potentially causing pulp issues and tooth sensitivity. The gaps at the tooth-restoration interface, known as microleakage, allow the ingress of acids, ions, enzymes, and their byproducts, increasing the risk of secondary caries. [1-3] Class II composite restorations, especially at the cervical margins, are particularly susceptible to microleakage and secondary caries. [4] Despite the introduction of dentin bonding agents, microleakage remains a common problem, as resin materials bond weaker to dentin compared to etched enamel. Moreover, the shrinkage of composite resin during polymerization can negatively affect bonding. However, improved restorative procedures have shown promising results in enhancing bond strength to dentin and cementum. [5] The primary disadvantage of using composite resin for Class II restorations, particularly at the gingival margin, is the occurrence of microleakage between the resin and the cavity walls. This microleakage is caused by gaps that form due to the polymerization shrinkage of the setting resin. These defects were believed to be a result of the polymerization shrinkage of the composite resin. In summary, the use of composite resin in Class II restorations is associated with the problem of microleakage, particularly at the gingival margin, due to gaps formed by resin shrinkage, as supported by the findings of the study. [6,7]

## MATERLAL AND METHODS

In the present study, forty-five exfoliated sound human primary molars or *extracted at time of shedding* were selected. All teeth were stored in distilled water at room temperature, before the restorative and testing procedures.

**Materials:**

**1. Vitremer**

The *VitremerTri-cure glass ionomersystem*is used as anesthetic restorative filling material. It consists of:

A. Tri-cure glass ionomer powder.

B. The glass ionomer liquid.

C. dentin / enamel primer.

D. Finishing gloss.

**2- Composite Z100:** The resin consists of bisphenol-A glycidyl I methacrylate *(8IS-GMA)* and triethylene glycol dimethacrylate *(TEGDMA)*. The filler is a synthetic mineral of zirconia / silica. In this study, the "pedo shade" was selected.

**3. Scotchbond Multipurpose Adhesive System**

**4. Artificial Saliva**

**METHODS:**

Each tooth was embedded in a resin block; packed in split metallic mold. The occlusal surface was placed in a perpendicular position to the long axis of the resin block.

The round end-cutting bur Nº 330* was used for preparing the occlusal box. The depth of the box was standardized according to the working length of the bur. A rounded end-cutting bur N º 245* was used for the preparation of the proximal box with a gingival depth mapping the working length of the bur. The burs were mounted on a high-speed handpiece with air / water coolant system. The teeth were randomly divided into three equal groups according to the restoration procedure, each group contained fifteen teeth.

**Group (I) [open Sandwich Technique] :**

The primer was applied with a brush for 30 seconds at the floor of the occlusal box, axial wall, and gingival step of the proximal box. Then it was dried using an air syringe, free of oil and water contaminants and light-cured for 20 seconds. The primed surfaces appeared "shiny' after the air-drying light-cured step. A transparent matrix was adapted around each tooth. The material used was then proportionated and mixed according to manufacturer's instructions.

- The *primer* of the *Scotcfibondwas* applied with a brush to etched surfaces and to remaining dentinal walls, then dried gently for 5 seconds.
- The *adhesive* was applied using a brush to all enamel, dentin, and glass ionomer surfaces, then light-cured for 10 seconds.
- *Composite resin* was placed in increments of 2 mm thick, starting from the base of the proximal box outwards, using a plastic instrument. The visible light beam was then applied for 40 seconds. Extra ten seconds were applied from both buccal and lingual sides so that the total exposure time was sixty seconds.

**Group (II) Closed Sandwich Technique**

The same steps were followed as in Group (I), except that glass ionomer liner was placed on the floor of the occlusal box and the axial wall of the proximal box only. The adhesive was applied using a brush to all enamel, dentine and glass ionomer surface, then light-cured for 10 seconds. The composite resin was applied on uncovered gingival step of the proximal box. The teeth were then stored in artificial saliva for one week.

**Group (III)[Open Sandwich Technique Without Etching]:**

Class II cavities were prepared as in Group (I) and Group (II). The glass ionomer liner was applied on the floor of the occlusal box, the axial wall and the gingival step of the proximal box then cured as in Group (I). Then, the dentin bond was applied to all primed surfaces including glass ionomer liner without surface etching and cured. The teeth were then restored using the composite resin as in Group (I) and Group (II). The teeth were stored in artificial saliva for one week.

**Microleakage Test**

All specimens were stored in artificial saliva for one week before thermocycling. The specimens were thermocycled in a water bath for 200 cycles, alternating between 5° and 60°C with one minute dwell time. After thermocycling, the teeth were washed and dried with oil-free compressed air.

Apices of the teeth were sealed with sticky wax. The teeth were coated with two layers of nail polish except for one area about 1 mm, around the margins of the restoration.

The teeth were then socked in 1% aqueous solution of basic fuchsin dye for 24 hours. Then, the teeth were rinsed in tap water. Each specimen was sectioned mesiodistally using a diamond saw through the center of the restoration. The extent of the dye penetration at the cavity margins was detected using a light stereomicroscope* (x16 magnification).

Microleakage at the gingival margin between the tooth structure and both glass ionomer liner and composite resin was assessed for the extent of dye penetration according to the following scoring system *(modified from Reid).*

*0 = No leakage.*

*1 = Leakage up to half-way along the gingival floor of the proximal box.*

*2 = Leakage to the full depth at the gingival floor of the proximal box.*

*3 = Leakage involving the axial wall of the proximal box.*

*4 = Extensive leakage extended towards the pulpal floor of the occlusal box.*

- The same scores were used to assess microleakage at the interface between the composite resin and the glass ionomer liner.
- Scores "1" and "2" were rated as "mild microleakage" and scores "3" and "4" as "severe microleakage".
- Readings of microleakage scores were tabulated and their percentages were determined and compared between the three different types of sandwich technique using.

## Results

The microleakage scores at the gingival margin between glass ionomer / tooth structure interface in open sandwich technique (group I) are presented in Table I and Graph (1).

Out of 15 specimens, microleakage was not detected in 13 specimens (score 0) which present 86.6% of the samples (Fig. 8). Only one specimen recorded a score of "1" dye penetration (6.7%). No samples with score "2" were detected. One specimen with score "3" microleakage was observed (6.7%) (Fig. 9). Severe microleakage (score 4) was not evident in any specimen of group (I) sandwich technique. Table II and Graph (2) show microleakage scores at the gingival margin between glass ionomer / composite interface in open sandwich technique (group I). Leakage was not revealed in 10 out of 15 specimens (66.7%) (Fig. 8). Two specimens showed a score of "1" dye penetration (13.3%). Score "2" microleakage was not observed in any specimen. Score "3" microleakage was detected in "3" specimens (20%) (Fig. 9), while severe dye penetration (score 4) was not evident.

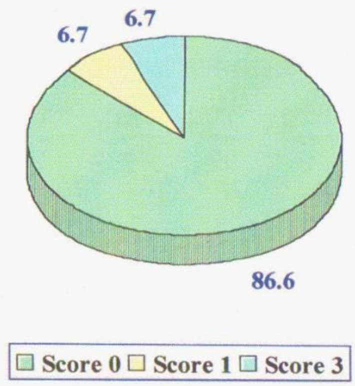
Table I: Microleakage scores at glass ionomer / tooth structure interface in open sandwich technique (group I).

| Score | Number (15) | Percentage (%) |
|---|---|---|
| 0 | 13 | 86.6 |
| 1 | 1 | 6.7 |
| 2 | — | — |
| 3 | 1 | 6.7 |
| 4 | — | — |

Table II: Microleakage scores at glass ionomer / composite interface in open sandwich technique (group I).

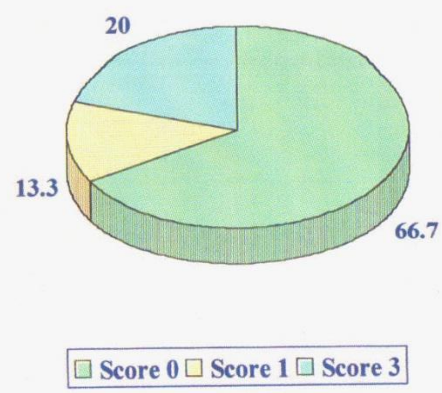
| Score | Number (15) | Percentage (%) |
|---|---|---|
| 0 | 10 | 66.7 |
| 1 | 2 | 13.3 |
| 2 | — | — |
| 3 | 3 | 20.0 |
| 4 | — | — |

Graph (1): Microleakage scores at glass ionomer / tooth structure interface in open sandwich technique (Group I).




Scores 2 and 4 were not evident

Graph (2): Microleakage scores at glass ionomer / composite interface in open sandwich technique (Group I)




Scores 2 and 4 were not evident

fig. (8): Longitudinal section in a lower primary second molar, showing Oass i! open sandwich technique (group I) without leakage at the gingival margin between glass ionomer / tooth structure or glass ionomer / composite interfaces.

fig. (9): Longitudinal section in a lower primary second moiar showing Class II open sandwich technique (group J) with score 3 microleakage at the gingival margin both between glass ionomer/ tooth structure and glass ionomer / composite interfaces.

The microleakage scores at the gingival margin between composite / tooth structure interface in closed sandwich technique (group II) are shown in Table III and Graph (3).

No leakage (score "0") was observed in 10 out of 15 specimens (66.7%) (Fig. 10).

Score "1" microleakage was detected in 3 specimens (20%). Score "2" microleakage was found in 2 cases (13.3%) (Fig. 11), while score "3" and score "4" were not evident in any specimens of group (II) sandwich technique. Table (IV) and Graph (4) present the microleakage scores at the gingival margin between glass ionomer / composite interface in open sandwich technique without etching (group III). No leakage (score 0) was detected in 9 out of 15 specimens (60%) (Fig. 12).

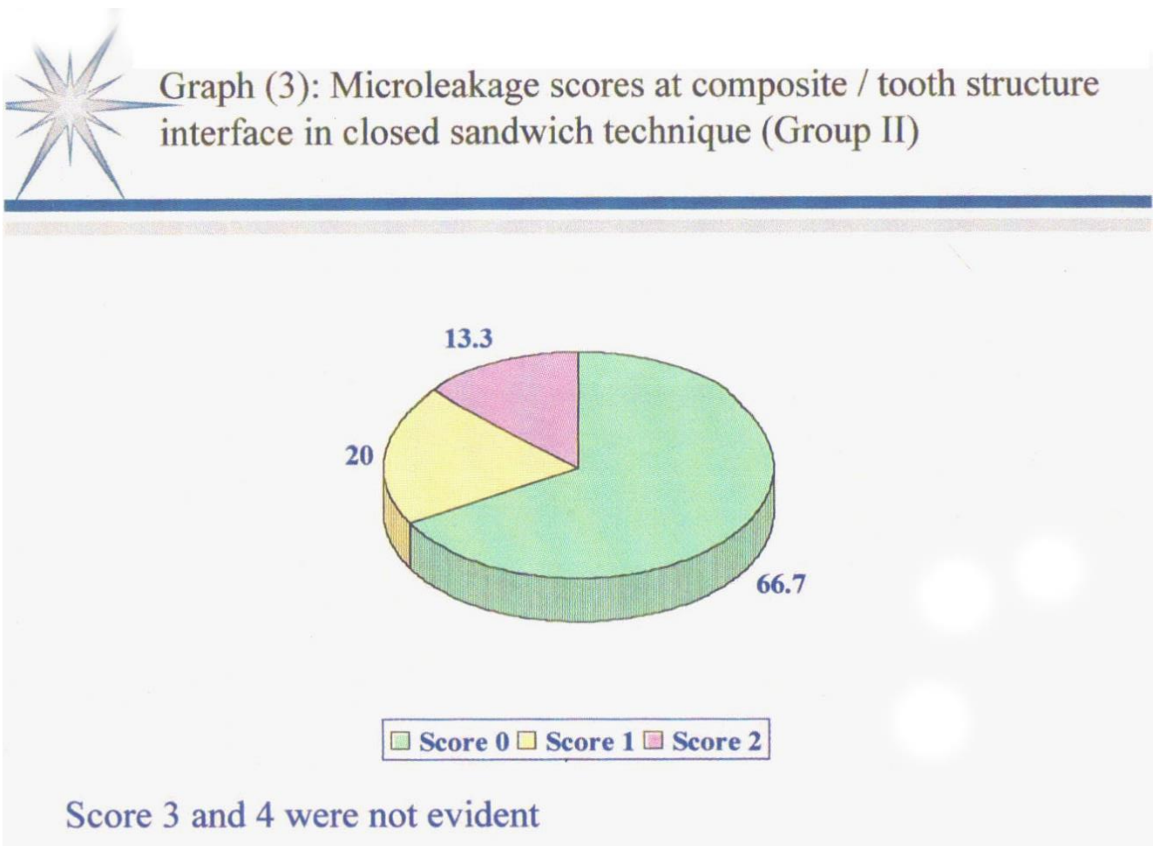
Score "1" and score "2" microleakage were observed in three specimens (20%) (Fig. 13) in each group. Score "3" and score "4" dye penetration were not evident in any samples of group (III) sandwich technique without etching.

Table III: Microleakage scores at composite / tooth structure interface in closed sandwich technique (group II).

| Score | Number (15) | Percentage (%) |
|---|---|---|
| 0 | 10 | 66.7 |
| 1 | 3 | 20.0 |
| 2 | 2 | 13.3 |
| 3 | -- | ~ |
| 4 | — | — |

Table IV: Microleakage scores at glass ionomer / composite interface in open sandwich technique without etching (group III).

| Score | Number (15) | Percentage (%) |
|---|---|---|
| 0 | 9 | 60.0 |
| 1 | 3 | 20.0 |
| 2 | 3 | 20.0 |
| 3 | - | — |
| 4 | — | -- |




Graph (3): Microleakage scores at composite / tooth structure interface in closed sandwich technique (Group II)

Score 3 and 4 were not evident

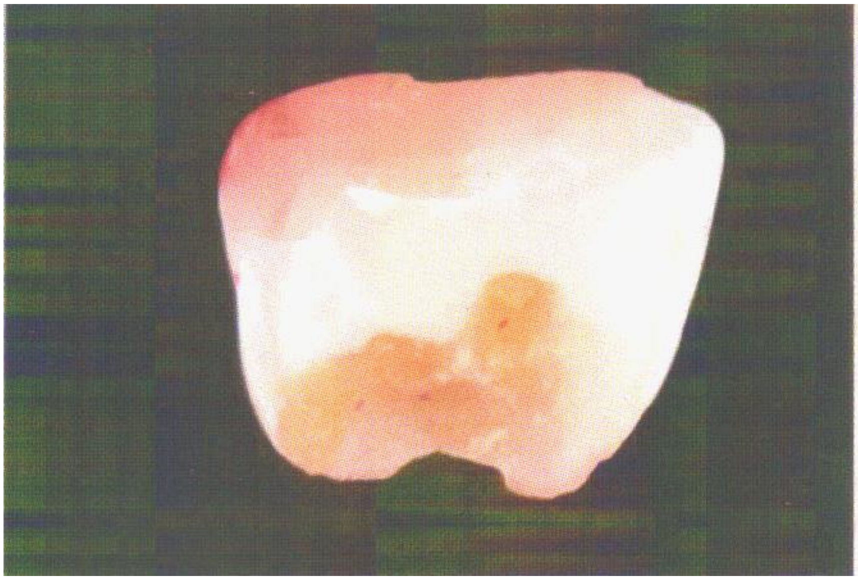


Fig (1): Longitudinal section in an upper primary second molar showing Class II closed sandwich technique (group II) without leakage at the gingival margin between composite / tooth structure interface.

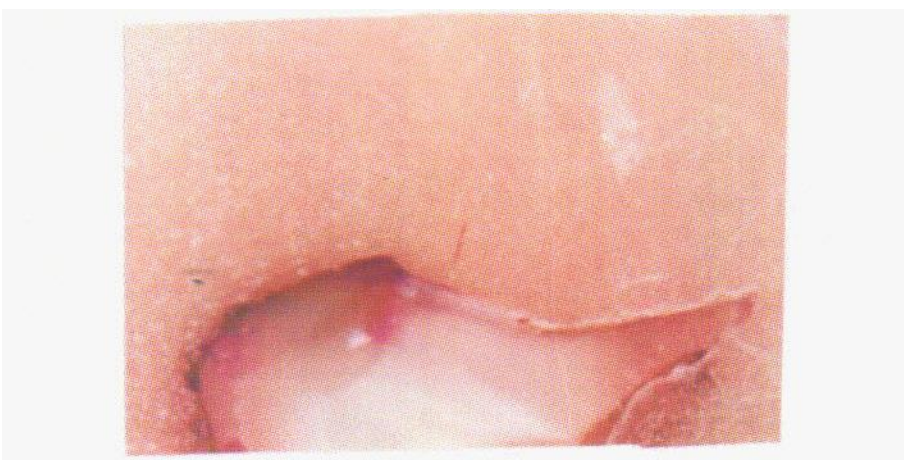


Fig. (2): Longitudinal section in a lower primary first molar showing Class II closed sandwich technique (group II) with score 2 microleakage at the gingiva margin between composite / tooth structure interface.

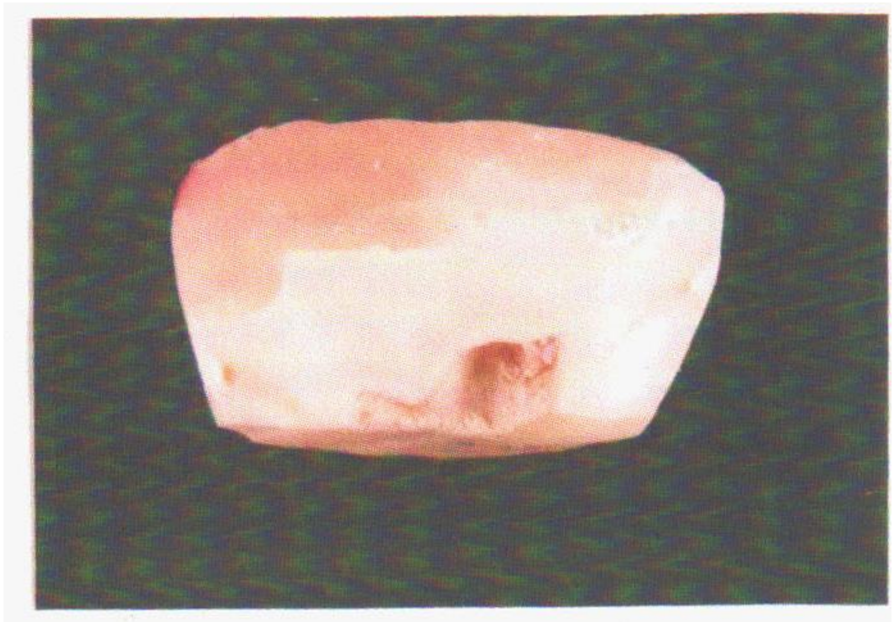


Fig. (3): Longitudinal section in an upper primary first molar showing Class II open sandwich technique without etcning (group III) with no leakage at trie gingivai margin between glass ionorner / composite interface.

Fig (4): Longitudinal section in a lower primary second molar showing Class II open sandwich technique without etching (group III) with score 1 microleakage at the gingiva' margin between glass ionomer / composite interface.

Table V and Graph (5) show the microleakage at the gingival margin between tooth structure / restoration interface in open (group I) and closed (group II) sandwich technique.

Microleakage was not observed in 86.6% of the specimens in group (I), and 66.7% in group (II).

Using the 2-test, the difference in dye penetration at the cervical margin between tooth structure / restoration interface in both groups was not statistically significant at the 5% level, where Z = 1.14 (P > 0.05).

Score "1" microleakage was evident in 6.7% of the specimens in group (I) and 20% of specimens in group (II).

No statistically significant difference was found between both groups at the 5% level, where Z = 0.31 (P > 0.05).

5: score "2" microleakage was not evident in group (I), while it was observed in 13.3% of the specimens in group (II).

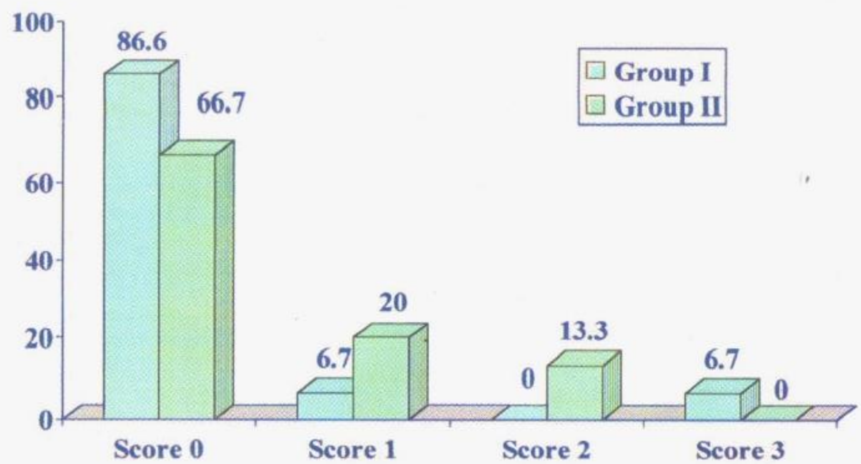
Score "3" microleakage was observed in 6.7% of the specimens in (I), while it was not detected in group (II).

Severe dye penetration (score "4") was not evident in any specimens of both groups.

Table V: Microleakage scores at tooth structure / restoration interface in open (group I) and closed (group II) sandwich technique.

| Score | Group I | | Group II | | Z Test |
|---|---|---|---|---|---|
| | Number | % | Number | % | |
| 0 | 13 | 86.6 | 10 | 66.7 | $1.14^{NS}$ |
| 1 | 1 | 6.7 | 3 | 20.0 | $0.31^{NS}$ |
| 2 | — | — | 2 | 13.3 | |
| 3 | 1 | 6.7 | — | — | *NS: Not Significant,* |
| 4 | - | — | — | — | |

Graph (5): Microleakage scores at tooth structure / restoration interface in open (Group I) and closed sandwich technique (Group II)



Microleakage scores at the gingival margin between glass ionomer / composite interface in open sandwich technique with and without etching are shown in Table VI and Graph (6). Leakage was not detected (score 0) in 66.7% of the specimens in group (I) and in 60.0% of the specimens in group (III). There was no statistically significant difference in dye penetration of glass ionomer / composite interface between group (I) and group (III) at the 5% level, where 2 = 0.30, (P > 0.05). Score "1" microleakage was observed in 13.3% of the specimens in group (I) and 20% of the specimens in group (III). The difference was not statistically significant at the 5% level, where 2 = 0.19, (P> 0.05).Score "2" microleakage was not detected in group (I), while it was observed in 20% of the specimens in group (III).Score "3" microleakage was evident in 20% of the restorations in group (I), while it was not detected in any specimens in group (III)Severe microleakage (score "4") was not evident in any samples of both groups. Table VI: Microleakage scores at glass ionomer / composite interface in open sandwich technique with (group I) and without etching (group III).

| Score | Group I | | Group III | | 2 Test |
|---|---|---|---|---|---|
| | Number | % | Number | % | |
| 0 | 10 | 66.7 | 9 | 60.0 | 0.30 $^{NS}$ 0.19 $^{NS}$ |
| 1 | 2 | 13.3 | 3 | 20.0 | |
| 2 | --- | -- | 3 | 20.0 | |
| 3 | 3 | 20.0 | -- | --- | |
| 4 | -- | -- | — | — | |

*NS: Not Significant.*

## DISCUSSION

In this study, microleakage scores at tooth structure / restoration interface were lower in the open than in the closed sandwich technique. These results indicated a stronger bond between glass ionomer and tooth structure than between composite resin and tooth structure. This finding might be the result of the coefficient of thermal expansion of glass ionomer materials that is quite similar to tooth structure. [8] Another factor responsible for this observation is the diffusion-based adhesion that occurs between the polyalkenoic acid and the glass powder as well as the tooth structure. The polyalkenoic acid removes the smear layer and surface contaminants and at the same time, it diffuses into the surface of the tooth, displacing phosphate ions. Each phosphate ion takes with it a calcium ion to maintain electrolyte balance at the interface, with the development of an ion-enriched layer between the two materials and a union of considerable strength. This union is based initially on hydrogen bonding and over time, matures and evolves into stronger chemical bond of a polar / ionic kind. [9]

The result of the present study is consistent with that of Rekha et al,[10] who reported lowest microleakage scores at the interface between the restoration and tooth structure of the proximal box in the open sandwich technique.

On the other hand, this finding is not in agreement with a clinical study done by Lindberg et al. [11] The difference in the findings between the latter and the present study could be due to a combination of factors with the open sandwich technique. Reasons suggested were technique difficulties in application of the lining material to the gingival step, dissolution, and wear of the glass ionomer cement as a result of moisture contamination associated with the approximal area.

The microleakage scores, in this study, were slightly lower between glass ionomer / composite resin interface, with etching than without etching. This is in agreement with Abd El Halim, S., and D. Zaki. [12] who found that etching generally improves the strength of the bond by removing the soluble polyacrylate matrix, thus providing a rough surface composed of pores, fissures, and intact glass particles. This substrate is then impregnated by the resin restorative, resulting in efficient polymer anchoring and micromechanical interlocking with the restorative resin.

The findings of the present study concur with the that of William and Eugene [13] which indicated that etching improves adhesion of resin to both chemically cured and resin-modified glass ionomer restorative materials.

On the other hand, Jafari, et al [14] found that acid-etching of glass ionomer liners results in significant alterations in their surface chemistry, their microleakage study revealed interfacial gaps and fractures in the etched samples. The best results were obtained from non-etched ionomer liners which were subjected to the adhesive treatment.

In this study, there were no significant differences in microleakage scores at glass ionomer composite interface between etched and unetched glass ionomer cement in the open sandwich technique because the bonding agent was applied immediately over the glass ionomer cement. Moreover, the bonding agent protected the cement during setting and still formed a strong bond to the resin surface of the composite, At the same time, the adhesive resin flowed over the cement and might become linked with the resin matrix of the glass ionomer cement.

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