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# COMPARISON OF EXTENT OF MICROLEAKAGE IN RESIN MODIFIED GLASS IONOMER CEMENT VERSUS FLOWABLE COMPOSITE LINING MATERIALS UNDER CLASS 2 COMPOSITE RESTORATION

**Dr. Zarmina Ismail[*1], Prof. Dr. Saroosh Ehsan[2], Dr. Misbah Ashfaq[3], Dr Samreen Aqeel[4], Muhammad Talha Khan[5]**

[*1,2,3,4]*Department of Operative Dentistry and Endodontics, FMH College of Medicine and Dentistry, Lahore*
[5]*CHPE Fatima Memorial Dental Hospital, Lahore*

[*1]zarmina1200@hotmail.com, [2]sarooshehsan77@gmail.com, [3]malik998@gmail.com, [4]sam.aqeel89@gmail.com, [5]dr_talhakhan@hotmail.com

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**Corresponding Author: ***
**Dr. Zarmina Ismail**

**Abstract**

***Objective:*** *To compare the extent of microleakage between resin-modified glass ionomer cement (RMGIC) and flowable composite when used as lining materials under Class II composite restorations.*

***Methodology:*** *Sixty caries-free extracted third molars were collected and randomly divided into two groups of 30 each. Teeth with amelogenesis imperfecta, dentinogenesis imperfecta, or fluorosis were excluded. Group I was lined with flowable composite, and Group II with RMGIC. Microleakage was assessed by dye penetration at the tooth-restoration interface under a stereomicroscope at 25X magnification. The depth of dye penetration indicated the extent of microleakage. Data were analyzed using an independent t-test.*

***Results:*** *The sample included 27 females (45%) and 33 males (55%), with a mean age of 33.68±9.85 years. The overall mean microleakage was 8.44±3.06 mm. Group II (RMGIC) showed significantly higher mean microleakage (10.65±2.20 mm) compared to Group I (flowable composite) with 6.23±2.02 mm ($p<0.001$). This significant difference persisted across all age groups and both genders ($p<0.001$).*

***Conclusion:*** *RMGIC demonstrated significantly greater microleakage compared to flowable composite when used as a lining material under Class II composite restorations. Microleakage was not associated with patient gender or age group.*

## INTRODUCTION

Polymerization shrinkage remains a significant concern in resin-based restorations, as it generates stresses at the tooth-restoration interface, compromising marginal seal and adaptability. [1] These stresses can lead to the formation of marginal gaps, allowing the ingress of bacteria, fluids, ions, and molecules from the oral cavity. This microleakage is a major contributor to restoration failure, resulting in postoperative sensitivity, recurrent caries, pulpal pathology, and marginal staining. [2]

One method to mitigate polymerization shrinkage is the application of a liner to the cavity floor. Acting as a flexible intermediate layer, the liner helps relieve polymerization stresses, thereby reducing microleakage.[3] Additionally, liners can decrease the configuration factor (C-factor) of the cavity and reduce the overall volume of composite used.[1]

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Commonly used lining materials include resin-modified glass ionomer cement (RMGIC) and flowable composites. RMGIC offers several advantages, including chemical bonding to tooth structure, micromechanical bonding with the composite restoration, fluoride release, and enhanced marginal integrity. [4] In contrast, flowable composites possess low viscosity, increased wettability, and elasticity, allowing for superior adaptation to cavity walls and floors. [5]

Several studies have compared the extent of microleakage between these two lining materials under composite restorations. [6] Benny et al.[7] reported greater microleakage with RMGIC (7.99 ± 9.57 mm) compared to flowable composite liners (1.50 ± 1.97 mm). Conversely, Ausiello et al.[6] found that RMGIC exhibited less microleakage (8.15 ± 6.87 mm) than flowable composites (12.35 ± 6.37 mm).

Given these conflicting findings, the superiority of either material as a liner remains inconclusive. Therefore, this study was designed to compare the extent of microleakage in Class II composite restorations lined with RMGIC versus flowable composites, to determine the optimal lining material that minimizes microleakage and enhances the longevity of restorations with minimal postoperative complications.

## METHODOLOGY

This cross-sectional study was conducted to compare the extent of microleakage between resin-modified glass ionomer cement (RMGIC) and flowable composite liners under Class II composite restorations. The study was carried out in the Department of Operative Dentistry at Fatima Memorial Hospital, Lahore, after obtaining ethical approval from the Institutional Review Board. The study duration was six months, from October 1, 2024, to January 10, 2025.

A total sample size of 60 teeth (30 per group) was calculated using a 95% confidence interval and 80% power, based on the following parameters:

- Mean microleakage for flowable composite liner: 1.50 ± 1.97 mm
- Mean microleakage for RMGIC liner: 7.99 ± 9.57 mm

Non-probability purposive sampling was used. The inclusion criterion was caries-free extracted third molars, while teeth with amelogenesis imperfecta, dentinogenesis imperfecta, or fluorosis were excluded.

Sixty extracted molars with intact occlusal surfaces were collected and stored in 10% formalin. Standardized Class II cavities were prepared using a No. 245 carbide bur in a high-speed handpiece with water cooling. Cavity dimensions were verified with a periodontal probe and included:

- Buccolingual width: 4 mm
- Axial depth at axio-pulpal line angle: 2 mm
- Gingival margin: 0.5 mm below the cementoenamel junction (CEJ) with a depth of 1 mm

Teeth were randomly assigned into two groups using the lottery method based on the lining material:

**Group I (Flowable Composite Liner):**

Cavities were etched with 37% phosphoric acid for 15 seconds, rinsed, and air-dried. A bonding agent was applied with a bristle brush, air-dried to remove excess, and light-cured for 20 seconds. A 1 mm thick layer of flowable composite liner was placed on the pulpal floor and light-cured for 20 seconds. The remaining cavity was restored with packable composite using incremental technique and light-cured for 20 seconds.

**Group II (RMGIC Liner):**

Cavities were conditioned with 60% polyacrylic acid for 20 seconds, rinsed, and air-dried. The gingival floor was lined with a 1 mm thick layer of RMGIC and light-cured. The remaining cavity was restored with packable composite (Ivoclar) using incremental technique and light-cured for 20 seconds.

All specimens were immersed in 2% aqueous methylene blue dye for 48 hours at room temperature. Teeth were then rinsed with water and air-dried. Each tooth was sectioned mesiodistally through the center of the restoration using a water-cooled slow-speed diamond bur. Microleakage was assessed under a stereomicroscope at 25X magnification by measuring the depth of dye penetration at the tooth-restoration interface.

Data were entered and analyzed using SPSS Version 23.0. Mean and standard deviation of microleakage

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(in millimeters) were calculated for each group. Independent samples t-test was applied to compare the groups, with a p-value ≤0.05 considered statistically significant.

**RESULTS**

The females were 27 (45%) and males were 33 (55%). The most common age group was 20-30 years having 26 (43.33%) followed by 31-40 years having 19 (31.67%). (Table 1)

| Variable | Characteristic | n(%) |
|---|---|---|
| Gender | Female | 27 (45.00) |
| | Male | 33 (55.00) |
| Age group (years) | 20-30 | 26 (43.33) |
| | 31-40 | 19 (31.67) |
| | 41-50 | 15 (25.00) |

**The mean age was 33.68±9.85 years and microleakage was 8.44±3.06 mm as shown in Table 2.**

| Characteristic | Mean (SD) |
|---|---|
| Age (years) | 33.68 (9.85) |
| Microleakage (mm) | 8.44 (3.06) |

**The mean microleakage was higher in RMGIC (10.65±2.20mm) than flowable composite (6.23±2.02mm) and the difference was statistically significant (p<0.001). (Table 3)**

| Characteristic | Flowable composite Mean (SD) | RMGIC Mean (SD) | p-value* |
|---|---|---|---|
| Microleakage | 6.23 (2.02) | 10.65 (2.20) | <0.001 |

**In both gender the microleakage was higher in RMGIC than flowable composite and the difference was very highly statistically significant (p<0.001). The details are given in Table 4.**

| Gender | Characteristic | Flowable composite | RMGIC | p-value* |
|---|---|---|---|---|
| Male | Microleakage | 5.90 (1.60) | 11.16 (1.91) | <0.001 |
| Female | Microleakage | 6.60 (2.42) | 9.98 (2.44) | <0.001 |

**In all age groups the microleakage was higher in RMGIC than flowable composite and the difference was very highly statistically significant (p<0.001). The details are given in Table 5.**

| Age group (years) | Characteristic | Flowable composite | RMGIC | p-value* |
|---|---|---|---|---|
| 20-30 | Microleakage | 5.81 (2.02) | 11.12 (1.85) | <0.001 |
| 31-40 | Microleakage | 6.63 (2.01) | 11.54 (1.95) | <0.001 |
| 41-50 | Microleakage | 6.67 (2.17) | 9.07 (2.20) | 0.06 |

**Fig 1 shows visually the higher microleakage in RMGIC than flowable composite with significant p-value.**

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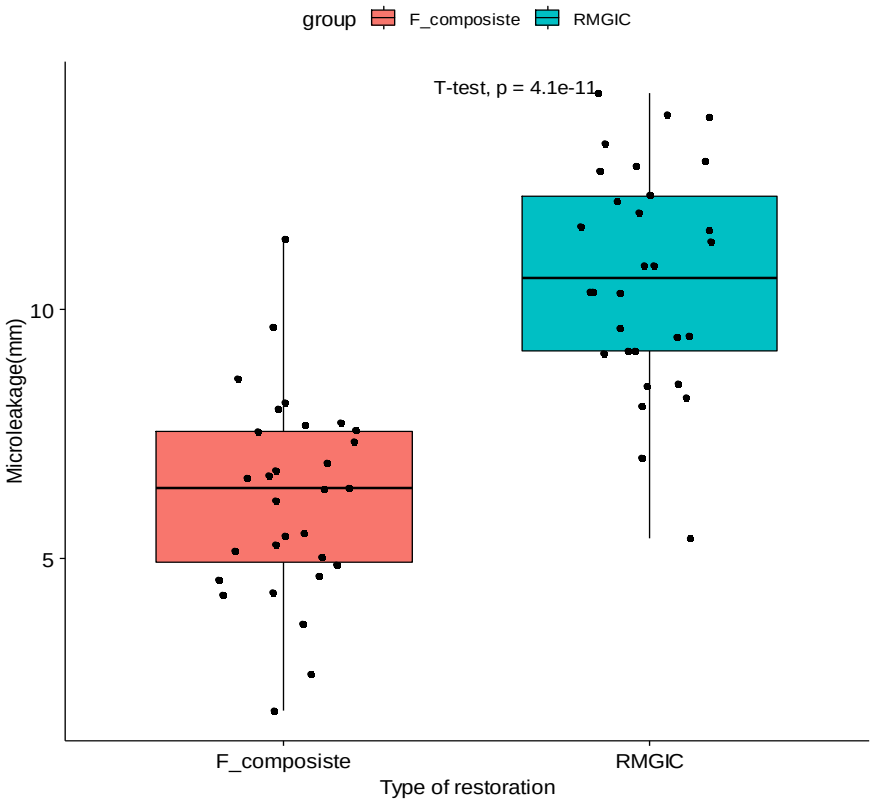


Fig 2 & 3 show the comparison of microleakage in both materials in genders and age groups.

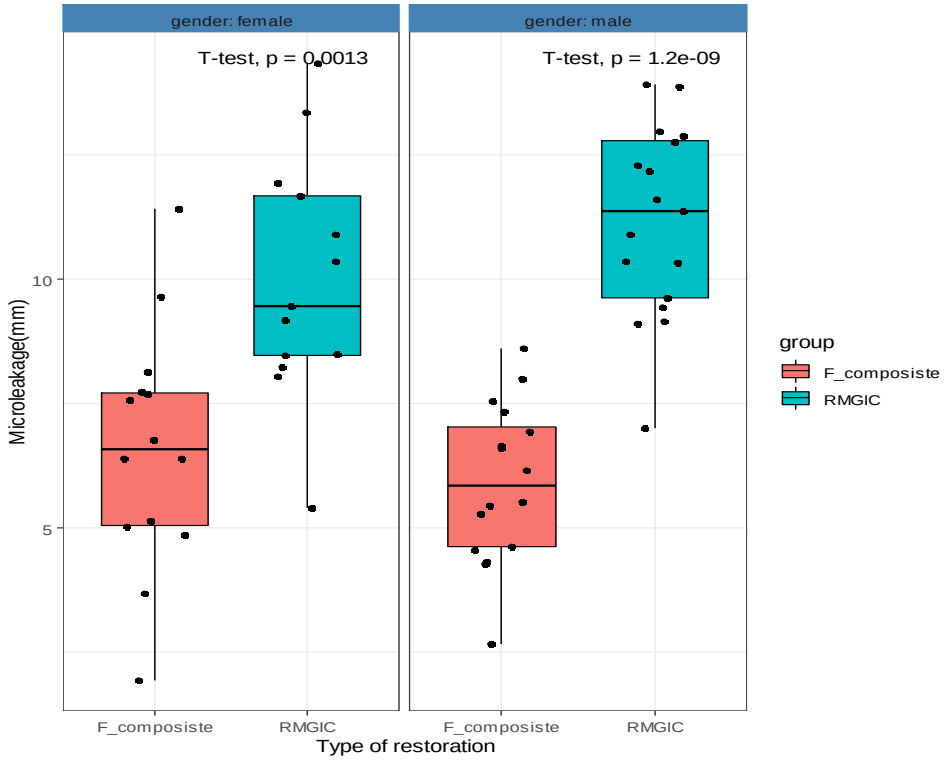


Fig 2: Comparison of microleakage between the two materials in both males and females

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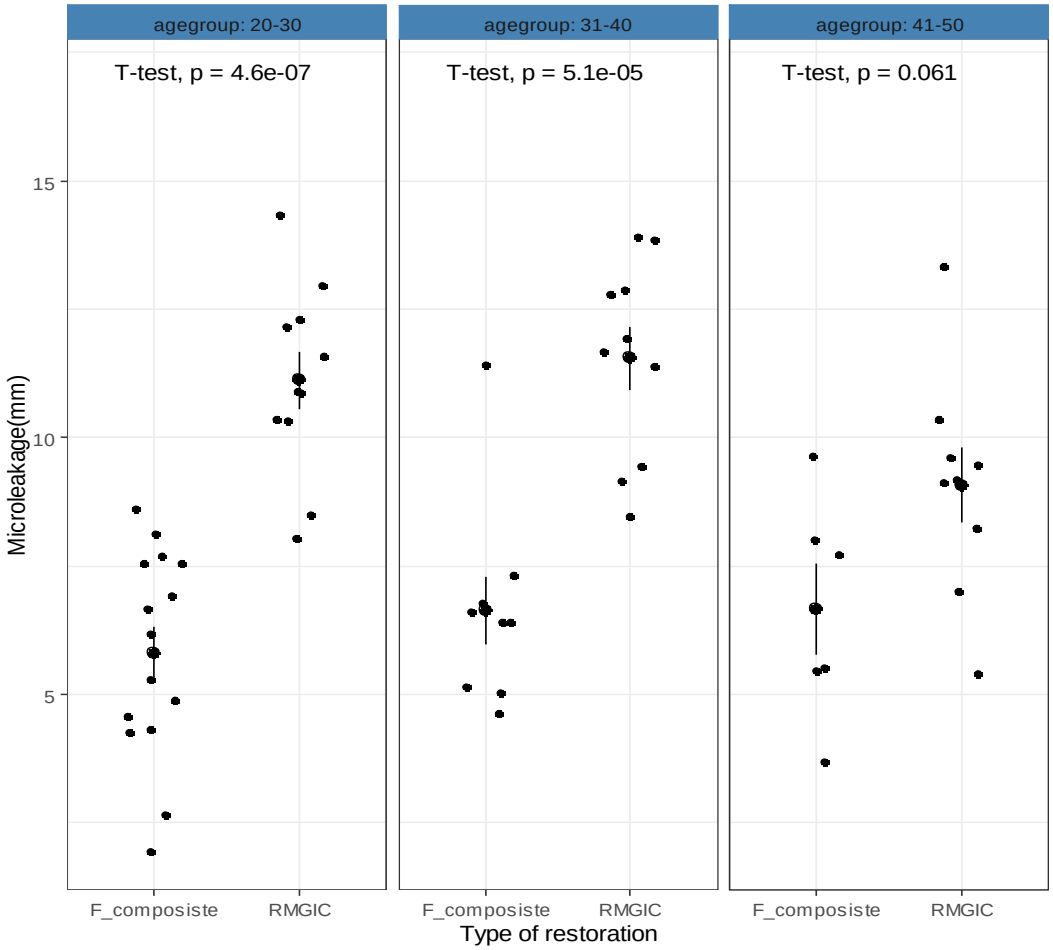


**Fig 1: Comparison of microleakage between the two materials in various age groups**

## DISCUSSION

Composite resin has been in use for anterior teeth restorations for over two decades. These are preferred over conventional amalgam restorations due to their superior aesthetic properties. With the new advancements and improved mechanical properties, composite is also used for posterior teeth restorations. The main advantage of using composite restoration in posterior teeth is their comparable mechanical properties to amalgam restorations as well as their ability to bond with the dental tissues (Enamel and Dentin) which results in better retention, improved strength and excellent aesthetic properties. However, due to the polymerization shrinkage, these restorations exhibits marginal leakage at their tooth-restoration interface , which can leads to marginal staining, dentinal sensitivity, secondary caries as well as restoration dislodgment. To counter this problem, many methods have evolved to reduce the marginal leakage. One of these methods is to use a lining material under the restoration. The most common lining materials are flowable composite and resin modified glass ionomer cement.

This study was aimed to compare the extent of microleakage in resin modified glass ionomer cement versus flowable composite lining materials under class 2 composite restoration. Our findings showed that the microleakage was higher in RMGIC than flowable composite.

Some of the materials which have been used as liners include Resin Modified Glass Ionomer cement (RMGI) and flowable composites. The advantages of using RMGI as a liner includes chemical bonding of cement to the tooth structure, micromechanical bond between the liner and composite restoration, fluoride release and marginal integrity.[4] Flowable composites have low viscosity, increased wettability

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and elasticity. This leads to a close adaptation between the restoration and cavity walls and floor.[5] RMGIC are hybrid restorative material which combines fluoro- aluminosilicate glass particles, polyacrylic acid, water, water-soluble methacrylate monomer with photoinitiator.[8] Restoring with conventional composite resin, low success rates were observed in cervical lesions resulting from the stiffness of the material. To overcome this, flowable composite resins which have filler loading reduced to 37%–53% (volume) when compared to conventional composites were introduced. Cention-N (Ivoclar, Vivadent) is a new "alkasite" restorative material, and manufacturers claim they have minimal shrinkage stress and volumetric shrinkage due to a patented filler technology (partially functionalized by silanes) and their monomer composition. They also claim that the material has improved flexural strength, and flexural fatigue resistance.[9] To improve mechanical and handling properties of glass ionomers, RMGICs were introduced which have the ion-releasing filler glass particles used in conventional GIC in smaller sizes.[10,11] The reduced filler loading in flowable composite, modifies its viscosity and allows it to adapt to the microstructural and macrostructural defects in the cavity.[12] Cention-N is a novel restorative material which are grouped under "Alkasites" group of material which combines both esthetics and improved flexural strength. This patented alkaline filler in Cention-N, reduces polymerization shrinkage stresses and also releases hydroxide ions which helps in regulating the pH during acid attacks. The high flexural strength due to cross-linked polymer structure make them ideal for class V restorations.[13]

A number of studies have been carried out to compare the micro leakage between lining materials composite restorations.[6] Benny RM et al.[7] reported greater extent of microleakage in RMGIC(7.99±9.57mm) as compared to Flowable composite liner (1.50± 1.97mm). In contrast, study conducted by the Ausiello P et al.[6] reported lesser microleakage extent for RMGIC(8.15±6.87mm) as compared to Flowable composite (12.35±6.37mm).

There is controversy in literature regarding the microleakage of RMGIC and flowable composite. A study by Zovko R et al. concluded that RMGIC had lesser degree of microleakage than flowable composite even after exposing them to different soft drinks and fruit juices for different immersion regimes.[14] Islam MS et al. compared for microleakage and noticed that the RMGIC performed better compared to that of conventional GIC. [15, 16] This is the results of two fold adhesion of RMGIC, bonding chemically to enamel and dentin and also by hybridization. CLSM demonstrated hybrid layer formation in dentin with RMGIC.[1]

## CONCLUSION

Within the limitations it can be concluded that microleakage in RMGIC is significantly higher than flowable composite. There was no association with gender and age groups.

## LIST OF ABBREVIATIONS

RMGIC: Resin Modified Glass Ionomer cement
ZnO-E Zinc oxide- eugenol
GIC: Glass ionomer cement
Hg: Mercury
Bis-GMA: bisphenol A-glycidyl methacrylate
TEGDMA: Tri ethylene glycol dimethacrylate SrO Strontium oxide

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## CONFLICT OF INTEREST

Authors hereby declare no conflict of interest in this study

## ETHICS APPROVAL

Ethical approval of the study was obtained from the ethical review committee of the institute.

## FUNDING

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## PATIENT CONSENT

Not applicable

## AUTHORS CONTRIBUTION

All authors contributed equally to the manuscript.

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