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Original Research Article

Comparative Evaluation of Marginal Microleakage in Class V Restorations of Primary Teeth Using Glass Ionomer, Resin-Modified Glass Ionomer, and Composite Resins with Different Bonding Systems

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Abstract: This study aimed to compare the extent of marginal microleakage in Class V restorations of primary teeth using three groups of restorative materials: glass ionomer cement (GIC), resin modified glass ionomer cement (RMGIC), and resin composites with different bonding systems. The importance of this investigation lies in the fact that microleakage is considered a major cause of failure in dental restorations, leading to postoperative sensitivity, secondary caries, and reduced longevity of restorations. In this experimental study, standardized Class V cavities were prepared on the buccal surfaces of human premolars and restored with the selected materials. Following thermocycling and immersion in dye solutions, dye penetration was assessed as an indicator of microleakage, and the data were statistically analyzed to determine differences among groups and between occlusal and gingival margins. The results revealed that microleakage was significantly higher at gingival margins compared to occlusal margins. Among the tested materials, RMGICs demonstrated superior performance in reducing marginal leakage compared to conventional GICs and resin composites. Resin composites, despite their favorable esthetics, exhibited the highest microleakage values due to polymerization shrinkage and bonding challenges in cervical dentin. These findings highlight the critical role of selecting appropriate restorative materials and bonding systems to ensure the clinical success of Class V restorations in primary teeth.

Keywords: Microleakage, Class V, Primary teeth, Glass ionomer cement, RMGIC, Resin composite, Bonding systems.

INTRODUCTION

Dental caries is one of the most prevalent oral health problems worldwide and shows a particularly high incidence among children. The significance of primary teeth is considerable, as they are not only highly susceptible to caries but also play a fundamental role in the growth and eruption of permanent teeth. One of the main causes of failure in dental restorations is microleakage, defined as the undetectable penetration of fluids, ions, and bacteria between the cavity walls and restorative materials, which may lead to postoperative sensitivity, secondary caries, and eventual restoration failure (Elsayed & Hammouda, 2023). Despite remarkable advances in esthetic dentistry, achieving complete marginal sealing remains challenging, especially in Class V cavities where the cervical margin often lacks sufficient enamel, making adhesion more difficult.

Various restorative materials have been introduced to address these challenges. Glass ionomer cements (GICs), first developed in the 1960s, gained importance due to their ability to exchange ions with tooth substrates and continuously release fluoride, although their mechanical weakness and moisture sensitivity remain limitations. Structural modifications such as the addition of resin (HEMA), mineral nanoparticles, and bioactive compounds have been employed to enhance their performance (Alsari et al., 2024). Resin-modified glass ionomer cements (RMGICs), which combine acid–base reactions with light-activated polymerization, exhibit superior mechanical and bioactive properties compared to conventional GICs, and their fluoride release reduces the risk of demineralization (Al Ghwainem & Alqarni, 2024). In contrast, resin composites, despite their esthetic advantages, demonstrate the highest microleakage due to polymerization shrinkage and bonding difficulties in cervical dentin (Elsayed & Hammouda, 2023). These comparisons highlight the critical importance of selecting appropriate restorative materials for the success of Class V restorations in primary teeth. Accordingly, the present study was designed to evaluate the effect of two types of glass ionomer cements and a resin composite combined with G-Bond and Clearfil Liner Bond F on microleakage in Class V cavities prepared in primary canines, conducted *in vitro* at the Islamic Azad University of Tehran during the academic year 2014.

Theoretical Background

Concept of Microleakage

Microleakage is defined as the passage of fluids and substances through extremely small gaps at the interface between the restoration and the tooth structure. In other words, bacteria, fluids, molecules, or ions can penetrate through the space between the restorative material and the cavity wall, a process referred to as microleakage. This phenomenon is considered a major cause of restoration failure, as it can lead to postoperative sensitivity, secondary caries, pulpal damage, and ultimately restoration breakdown. In addition to pulp irritation and secondary caries, microleakage also results in marginal discoloration and deterioration of restorations. Therefore, microleakage is regarded as a critical parameter for evaluating the success of any restorative material (Jangada et al., 2024).

From a theoretical perspective, microleakage is an indicator of failure because it compromises marginal sealing, jeopardizes the restoration, and increases the likelihood of secondary caries and postoperative sensitivity. Marginal integrity, defined as the contact surface between the restoration and the hard dental tissue, is of great clinical importance, since inadequate sealing can cause hypersensitivity, marginal discoloration, secondary caries, and pulpal inflammation. Marginal leakage, particularly in restorations with cervical margins located in dentin, is considered the primary factor responsible for hypersensitivity, secondary caries, marginal discoloration, and pulpal damage. Marginal sealing directly influences the longevity of dental restorations (Prabhakar et al., 2024).

One of the most essential requirements for the success of restorations is the prevention of microleakage, which is achieved by ensuring effective adhesion of the restorative material to the cavity walls. The inability of restorative materials to establish complete marginal sealing leads to the formation of microcracks, allowing the penetration of ions, fluids, and bacteria, which ultimately results in pulp infection, secondary caries, and postoperative sensitivity (Nadendla et al., 2025).

Specific Characteristics of Class V Cavities in Primary Teeth

Cervical lesions, both carious and non-carious, are common clinical findings. Due to the absence or limited presence of enamel at the cervical margin and the proximity to the gingiva, these lesions present significant challenges for restorative procedures. Contamination by gingival crevicular fluid or blood during treatment may compromise marginal sealing. For the restoration of such lesions, glass ionomer cements (GICs) and resin-modified glass ionomer cements (RMGICs) are widely used. Systematic reviews have demonstrated that RMGICs provide higher retention rates in non-carious cervical lesions compared to resin composites, although fewer studies have evaluated their performance in carious Class V lesions (Santos et al., 2023).

The complex structure of Class V cavities, with margins composed of both dentin and enamel, poses a major challenge for restorative materials. Microleakage along the cervical wall, particularly in composite restorations, remains a serious problem and is considered a primary cause of restoration failure (Hanoon et al., 2024). Bonding to dentin near the gingival margin is more difficult because this substrate has higher organic content, tubular orientation variability, greater fluid pressure, and lower surface energy compared to enamel, all of which limit the achievement of stable adhesion (Nadendla et al., 2025). Consequently, the specific characteristics of these cavities highlight the critical importance of selecting appropriate restorative materials and bonding systems to ensure clinical success in Class V restorations of primary teeth.

In Figure 1, a standardized Class V cavity with defined dimensions (5 × 3 × 2 mm) was prepared on the buccal surface of human premolars, with the occlusal margin located in enamel and the cervical margin in dentin. This design was chosen to simulate real clinical conditions and to allow precise evaluation of marginal adaptation and microleakage in both substrates.

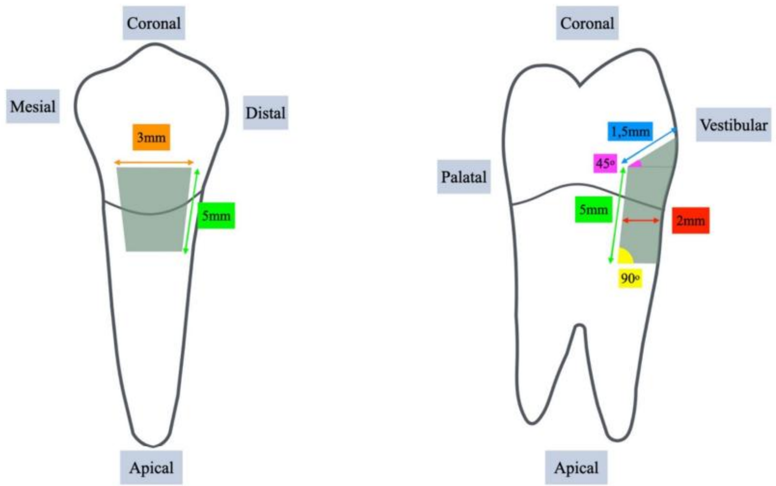

Figure 1: Graphical representation of the standardized Class V cavity design (Source: Baldi et al., 2025).

Restorative Materials Studied: GIC, RMGIC, Composite

Historically, Class V cavities were restored using amalgam and gold; however, these methods were largely abandoned due to esthetic concerns. Subsequently, glass ionomer cements (GICs) were introduced, but their limited wear resistance, insufficient hardness, and low fracture toughness led to the development of newer esthetic hybrid materials such as giomers. Giomers are based on pre-reacted filler technology, in which pre-reacted glass particles are chemically bonded to the resin matrix, thereby enhancing mechanical properties. Another material, Cention-N, classified as an "alkasite" restorative, belongs to the subgroup of composite materials and includes compomers and ormocers. Cention-N releases a considerable amount of fluoride ions, comparable to conventional GICs (Nadendla et al., 2025).

The longevity of resin-based composite (RBC) restorations critically depends on their ability to establish a reliable marginal seal, which is essential for preventing microleakage at the tooth–restoration interface. Flowable composites were developed to facilitate placement within cavities, improve adaptation to internal surfaces, and enhance interfacial sealing. In early formulations, filler content was significantly reduced (37–53% by volume) compared to conventional composites (50–70% by volume), resulting in poor clinical performance. More recently, high-filler flowable resin-based composites (HFRBCs) have been developed to combine the desirable handling properties of flowable composites with the mechanical and esthetic characteristics of conventional hybrid composites. Manufacturers claim that HFRBCs exhibit mechanical, physical, and esthetic properties equal to or superior to many traditional hybrid composites. Their ease of placement within cavities, combined with mechanical properties comparable to conventional composites, makes them particularly suitable for the long-term success of Class V restorations (Baldi et al., 2025).

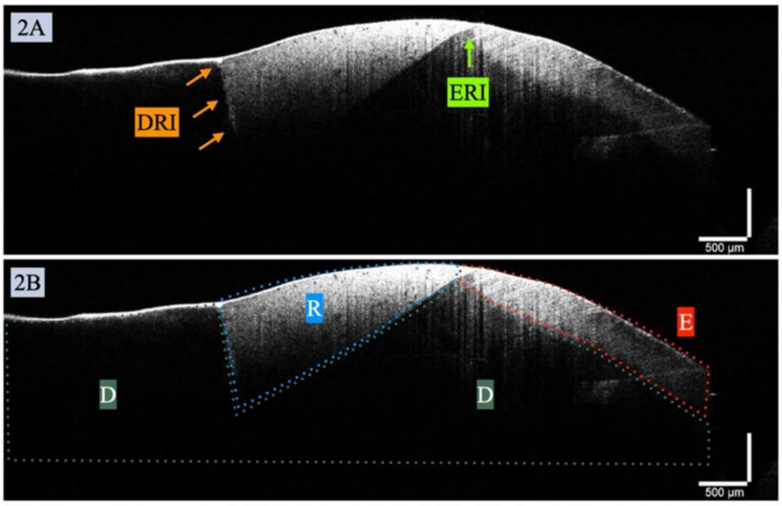

Figure 2: Sample without gap at the dentin–resin and enamel–resin interfaces (illustrating composite adaptation to dentin and enamel) (Source: Baldi et al., 2025).

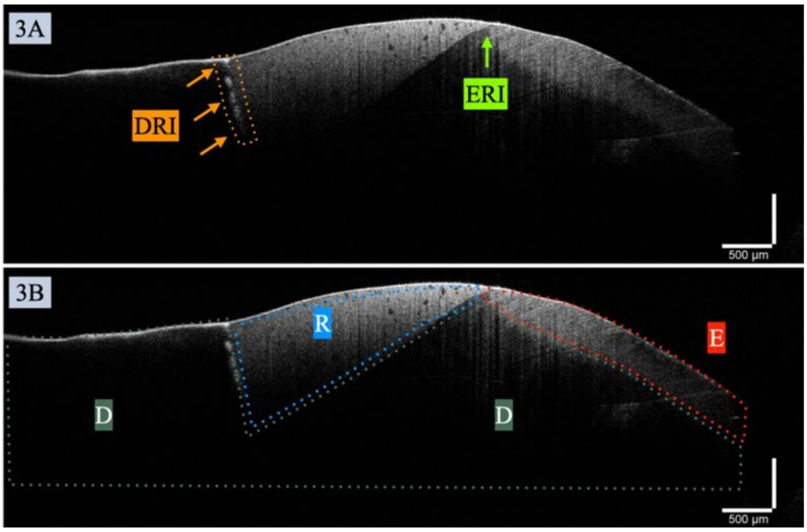

Figure 3: Sample with a visible gap at the dentin–resin and enamel–resin interfaces (illustrating the presence of separation between composite and tooth structure) (Source: Baldi et al., 2025).

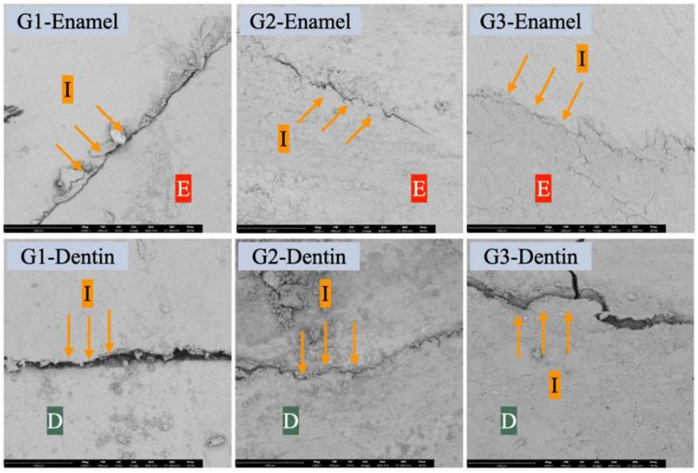

Figure 4: Scanning electron microscope (SEM) images of composite interfaces with enamel and dentin for

different groups of composite materials (Source: Baldi et al., 2025).

Restorative Materials

GC G-aenial is a light-cured, radiopaque hybrid composite composed of multifaceted particles and diverse fillers. The size and distribution of these particles are engineered to work synergistically, thereby reducing polymerization shrinkage and achieving superior esthetic outcomes (Prabhakar et al., 2024).

Tokuyama Palfique LX-5 is a novel resin-based restorative material reinforced with spherical super-nano particles. It exhibits outstanding properties such as high wear resistance, minimal abrasion against opposing teeth, low polymerization shrinkage, and adequate radiopacity, which have contributed to its widespread clinical application (Prabhakar et al., 2024).

Tetric N-Ceram, classified as a nanohybrid composite, demonstrates favorable marginal sealing capacity. This is likely attributed to its high filler load and low coefficient of thermal expansion, features that help compensate for stresses induced by polymerization shrinkage (Prabhakar et al., 2024).

Role of Bonding Systems in Reducing Microleakage

Adequate adhesion between resin composites and dentin is a critical factor for increasing the longevity of restorations. The bonding of composites to dentin is influenced by several variables, including cavity configuration, dentin depth, polymerization behavior of the composite, type of bonding system, and the restorative material itself. Polymerization shrinkage generates stresses that compromise marginal integrity, and this effect is directly related to the configuration factor (C-factor) (Prabhakar et al., 2024). Studies have demonstrated that the application of bonding agents prior to the use of self-adhesive composites enhances bond strength and reduces microleakage at both enamel and dentin margins (Mofidi et al., 2022).

Challenges of Cervical Bonding and the Role of Bonding Systems in Reducing Microleakage

The nature of dentin in the cervical region, due to its high organic content, variable tubular orientation, and fluid pressure, makes achieving stable bonding particularly difficult. Formation of a hybrid layer and resin infiltration into dentinal tubules are essential for optimal bond strength, and two-step self-etch systems generally demonstrate superior performance compared to three-step etch-and-rinse systems. The presence of sclerotic dentin, characterized by occluded tubules, further restricts resin penetration and reduces micromechanical interlocking. Pre-treatment methods such as sandblasting or mild acids may improve bonding surfaces, although their clinical relevance remains controversial.

Table 1: Factors Influencing Bond Strength in Class V Restorations and Their Clinical Implications

Factor	Description	Clinical Implication
Tooth Substrate	Enamel, dentin, or cementum. Dentin and cementum have lower mineral content.	Requires careful adhesive selection and pretreatment for optimal hybrid layer formation.
Sclerotic Dentin	Mineralized dentin with occluded tubules found in NCCLs.	Reduced resin infiltration and micromechanical retention. Surface modification helpful.
Adhesive System	Etch-and-rinse vs. self-etch adhesives.	Two-step self-etch systems offer better bond strength with less technique sensitivity.
C-Factor	Configuration factor influencing shrinkage stress.	High in Class V lesions; incremental placement and low-shrinkage composites recommended.
Polymerization Shrinkage	Volumetric contraction during curing of composites.	Can cause marginal gap formation and adhesive failure.
Moisture Control	Saliva, blood, or dentinal fluid contamination.	Isolation critical to avoid compromised bonding. Rubber dam preferred.
Flexural Stress (Abfraction)	Forces at cervical region due to occlusal loading.	Use of flexible, low-modulus materials improves stress absorption and longevity.
Operator Technique	Handling of adhesive and composite, curing protocols.	Variability in technique directly impacts bond strength and clinical outcomes.
Aging and Degradation	Hydrolytic breakdown of adhesive components over time.	Newer adhesives include nanofillers and bioactive agents to enhance durability.

(Sheogobind et al., 2025)

Additionally, the configuration factor (C-factor) in Class V restorations concentrates polymerization shrinkage stresses at the margins, increasing the risk of bond failure. Strategies such as using low-shrinkage composites, incremental placement techniques, and flowable composites with lower modulus of elasticity can mitigate these effects. Long-term clinical studies confirm that higher bond strength is associated with reduced microleakage and restoration failure; however, clinical success also depends on proper isolation, operator skill, and patient-specific factors. Emerging bonding technologies incorporating nanofillers and bioactive compounds have been introduced to enhance durability and promote regeneration of the tooth–restoration interface (Sheogobind et al., 2025).

Research Background

Recent studies indicate that novel restorative materials such as bioactive composites, alkasites, and resin-modified glass ionomer cements (RMGICs) demonstrate superior performance compared to conventional glass ionomers in terms of maintaining marginal sealing, enhancing bond strength, and reducing microleakage. For instance, bioactive composites have proven more effective in preventing microleakage, while alkasites and RMGICs exhibit comparable or higher shear bond strength than traditional glass ionomers (Kini et al., 2025; Sulimany et al., 2024).

Bulk-fill composites have also emerged as efficient alternatives to conventional composites, offering simplified restorative procedures while preserving desirable mechanical properties, particularly in deep cavities (Javed et al., 2024). Laboratory methods for evaluating microleakage are primarily based on dye penetration and nuclear medicine techniques, each with distinct advantages and limitations (Vieira et al., 2025).

Furthermore, both clinical and laboratory investigations have shown that self-adhesive flowable composites possess lower shear bond strength compared to conventional flowable composites, and thermo-mechanical cycling can reduce marginal and internal adaptation. However, the use of short-fiber reinforced flowable composites has been reported to improve durability (Saleh et al., 2025). In primary teeth restorations, ormocers and alkasites have demonstrated superior performance in reducing microleakage and increasing bond strength compared to conventional composites (Shono & Alkhudhairy, 2025).

Systematic reviews have also highlighted that both high-viscosity glass ionomer cements (HVGICs) and resin composites provide acceptable clinical effectiveness and durability in pediatric restorations, although longer-term studies are required for more precise evaluation (Krishnakumar et al., 2025). Collectively, these findings provide valuable guidance for selecting optimal restorative materials in contemporary dentistry.

MATERIALS AND METHODS

This experimental in-vitro study was conducted on 48 extracted primary canines removed for orthodontic purposes. Following examination to ensure soundness (absence of cracks, caries, or previous restorations), the teeth were disinfected with 5% chloramine and stored in normal saline. Standardized circular cavities, 3 mm in diameter and 1 mm in depth, were prepared on the middle buccal surface of each tooth using a diamond bur operated by a dental resident. The occlusal margin of the cavity was located on enamel, while the gingival margin was placed 1 mm below the cementoenamel junction (CEJ), with no mechanical retention incorporated into the design.

After rinsing dentin and enamel surfaces with a water spray and gently air-drying the cavities, the specimens were randomly assigned into four groups of 12 teeth each, to evaluate different restorative materials. The study population consisted of primary canines extracted for orthodontic reasons, free of cracks, caries, restorations, or fractures. Based on a pilot study, the sample size was determined as 12 teeth per group. Allocation of specimens into the main groups was performed using simple randomization.

Study Groups

Group A

Restorative Material: High-filled conventional glass ionomer cement (EQUIA, GC Corporation, Japan)

Group B
Restorative Material: Resin-Modified Glass Ionomer Cement (FUJI II LC, GC Corporation, Japan)

Group C
Restorative Material: Microhybrid composite (Gradia, GC Corporation, Japan) combined with a one-step self-etch bonding system, 7th generation G-Bond (GC Corporation, Japan).

Group D
Restorative Material: Microhybrid composite (Gradia, GC Corporation, Japan) combined with a two-step self-etch bonding system, 6th generation Clearfil Liner Bond F (Kuraray, Japan).

The properties of the materials used in this study, according to the manufacturer's brochure, are presented in the table below.

Table 2: Properties of Restorative Materials According to Manufacturer's Brochure

Material Name	Manufacturer	Main Components
Glass Ionomer Fuji IX Conventional High-Filled (EQUIA)	GC Corporation, Japan	Fluoro-aluminosilicate glass, polyacrylic acid, tartaric acid, nano-cluster fillers
Resin-Modified Glass Ionomer FUJI II LC	GC Corporation, Japan	Alumino-fluoro-silicate glass powder; liquid: polyacrylic acid, HEMA, 1,2,2,4 trimethyl hexamethylene dicarbonate, TEG-DMA
Microhybrid Composite (Gradia)	GC Corporation, Japan	Light-cured microhybrid composite resin with 85 wt% filler content
Direct GC Gradia	GC Corporation, Japan	Microhybrid composite resin; matrix based on UDMA (urethane dimethacrylate).
G-Bond	GC Corporation, Japan	One-step self-etch bonding system (7th generation); contains 4-MET and phosphoric acid ester; free of HEMA; includes ~5% nano-fillers; solvent: water and acetone.
Clearfil Liner Bond F	Kuraray, Japan	Two-step self-etch bonding system (6th generation); contains HEMA and 10-MDP; solvent: water.

Group I :In the first group, 10% polyacrylic acid conditioner was applied to the cavity using a microbrush for 20 seconds with a rubbing motion. The cavity was then thoroughly rinsed with an air-water spray for 20 seconds. Subsequently, an EQUIA capsule was mixed in an amalgamator for 10 seconds at a speed of 4000 rpm. Immediately after mixing, the capsule was placed in the special applicator gun and directly injected into the cavity.

After 3.5 minutes, corresponding to the initial setting time, excess restorative material was removed using a sharp flame-shaped bur (yellow ring, SO014 NO862, Kavo). The restorations were polished sequentially with composite finishing discs (KerrHawe, USA) in the order of navy blue, blue, green, and white, according to their abrasiveness, under continuous water cooling.

The restoration surface was then rinsed with an air-water spray for 5 seconds and completely dried with air for 10 seconds. A layer of G-Coat was applied over the restoration and light-cured for 40 seconds at an intensity of 700 mW/cm² using an LED curing unit (Dentamerica, Taiwan), positioned perpendicularly to the restoration. The tip of the curing device was placed in direct contact with the restorative material using a transparent mylar matrix strip. For all restorative procedures, the light-curing unit was checked with a radiometer prior to each use.

Group II – Resin-Modified Glass Ionomer (FUJI II LC):
A 10% polyacrylic acid conditioner (GC Corporation, Japan) was applied to the cavity with a rubbing motion for 20 seconds. The cavity was then thoroughly rinsed with an air-water spray for 20 seconds. The FUJI II LC capsule was mixed in an amalgamator (VENTURA Mix2, Spain) for 20 seconds at 4000 rpm. Immediately after mixing, the capsule was placed in the applicator gun and directly injected into the cavity. A transparent Mylar matrix was positioned, and the restoration was light-cured for 20 seconds using an LED curing unit at an intensity of 700 mW/cm². The curing tip was in direct contact with the matrix. Finishing and polishing were performed as described for Group I.

Group III – Microhybrid Composite + G-Bond:
The enamel surrounding the cavity was etched with 37% phosphoric acid gel (Ultradent) for 30 seconds, followed by rinsing with an air-water spray for 20 seconds. Excess water was removed with a cotton pellet, leaving the cavity slightly moist. A single layer of G-Bond was applied for 30 seconds, air-dried for 30 seconds, and light-cured with an LED unit at 700 mW/cm². A microhybrid composite (Gradia, GC Corporation, Japan) was placed in two increments: the first in the gingival portion and the second in the occlusal portion. A Mylar matrix was applied, and each increment was individually light-cured for 40 seconds at 700 mW/cm². The curing tip was in contact with the matrix. Finishing and polishing were performed as in Group I.

Group IV – Microhybrid Composite + Clearfil Liner Bond F:
The enamel margins were etched with 37% phosphoric acid gel (Ultradent) for 30 seconds, rinsed with an air-water spray for 20 seconds, and gently blotted with a cotton pellet to maintain slight moisture. Clearfil Liner Bond F primer was applied with a microbrush for 30 seconds, followed by gentle air-drying for 30 seconds to evaporate the solvent. The adhesive component was then applied and light-cured for 40 seconds at 700 mW/cm². A microhybrid composite (Gradia, GC Corporation, Japan) was placed in two increments (gingival and occlusal), each covered with a Mylar matrix and light-cured for 40 seconds at 700 mW/cm². The curing tip was in direct contact with the matrix. Finishing and polishing were performed as in Group I.

Thermocycling and Microleakage Assessment
After preparation, all specimens were stored in normal saline at room temperature for 24 hours. They were then subjected to thermocycling (500 cycles) between 5°C and 55°C, with a dwell time of 1 minute and a transfer time of 35 seconds (Fig. 1). Two layers of nail varnish were applied to all tooth surfaces except for a 1-mm zone around the restoration. To prevent silver nitrate penetration, the apical and furcation areas were sealed with sticky wax.

Specimens were immersed in 50% silver nitrate solution (Ranbaxy Ind. Ltd) at room temperature for 2 hours in darkness, followed by immersion in a developer solution (D76, Kodak Ind. Ltd) under fluorescent light for 6 hours to facilitate silver ion reduction. This process produced black staining, revealing the pattern of silver ion penetration at the tooth–restoration interface. Samples were rinsed under running water for 5 minutes, nail varnish was removed with a scalpel blade, and teeth were mounted in acrylic blocks (Fig. 2).

Finally, specimens were sectioned through the center of the restoration using a Mecatom cutting machine (Presse, France) equipped with a 0.5-mm diameter blade under water cooling, yielding two cross-sections for microleakage evaluation.

Microleakage was assessed according to ISO 11405 standards using a stereomicroscope (Nikon SMZ 800, Japan) at

10× magnification in four regions (occlusal and gingival margins) (Fig. 3). For each section, two values were obtained; the higher score for each margin was recorded. The examiner was blinded to the restorative material type (*single-blind design*).

Microleakage Scoring System:

- 0 = No penetration
- 1 = Penetration into the enamel portion of the cavity
- 2 = Penetration into the dentin portion of the cavity without reaching the pulpal floor
- 3 = Penetration into the pulpal floor of the cavity

For cavities located entirely in dentin, the scoring criteria were as follows:

- 0 = No penetration
- 1 = Penetration along the interface between the restorative material and dentin without reaching the pulpal floor
- 2 = Penetration into the pulpal floor of the cavity

Observation and Agreement

During evaluation, the opinion of a pediatric dentistry specialist was also obtained to achieve consensus. The intra-examiner Kappa coefficient was calculated as 0.93, indicating excellent agreement.

Statistical Analysis:

The findings were analyzed using the Kruskal–Wallis test with a confidence level of $p < 0.05$.

Figure 5

RESULTS

The study was conducted on 48 eligible primary teeth, and the findings are as follows:
In general, no statistically significant differences in microleakage were observed among the restorative materials at either margin.

Microleakage findings at the gingival margin:
Table 1 presents the number and percentage of specimens with different degrees of microleakage at the gingival margin. The Kruskal–Wallis test revealed that the lowest microleakage at the gingival margin was observed in the GC Gradia + Clearfil group, followed by FUJI II LC, then GC Gradia + G-Bond, while the highest microleakage was recorded in the EQUIA group ($p = 0.5$).

Table 3: Frequency Distribution and Percentage of Microleakage at the Gingival Margin

Group	Microleakage Scores	Total	p-value		
	0	1	2		
Glass Ionomer (EQUIA)	0 (0%)	5 (41.6%)	7 (58.4%)	12 (100%)	p = 0.5
Glass Ionomer (FUJI II LC)	0 (0%)	8 (66.7%)	4 (33.3%)	12 (100%)	—
Composite (GC Gradia + G-Bond)	1 (0%)	8 (50%)	3 (50%)	12 (100%)	—
Composite (GC Gradia + Clearfil Liner Bond F)	1 (8.3%)	8 (66.7%)	3 (25%)	12 (100%)	—
Total	1	27	20	48	—

Microleakage Findings at the Occlusal Margin

Table 3 presents the number and percentage of specimens with different degrees of microleakage at the occlusal margin. The Kruskal–Wallis test indicated that the lowest microleakage at the occlusal margin was observed in the GC Gradia + Clearfil group, followed by FUJI II LC, then GC Gradia + G-Bond, while the highest microleakage was recorded in the EQUIA group (*p = 0.2*).

Table 4: Frequency Distribution and Percentage of Microleakage at the Occlusal Margin

Group	Microleakage Scores	Total	p-value			
	0	1	2	3		
Glass Ionomer (EQUIA)	2 (16.7%)	3 (25%)	5 (41.6%)	2 (16.7%)	12 (100%)	p = 0.2
Glass Ionomer (FUJI II LC)	3 (25%)	5 (41.6%)	3 (25%)	1 (8.4%)	12 (100%)	—
Composite (GC Gradia + G-Bond)	3 (25%)	4 (33.4%)	5 (41.6%)	0 (0%)	12 (100%)	—
Composite (GC Gradia + Clearfil Liner Bond F)	4 (33.4%)	5 (41.6%)	3 (25%)	0 (0%)	12 (100%)	—
Total	12	17	16	3	48	—

DISCUSSION

The present study was conducted to evaluate microleakage of two self etch adhesive systems and two types of glass ionomer restoratives in Class V cavities of primary canines. Based on the results, the lowest microleakage was observed in the Clearfil Liner Bond F self etch adhesive group, followed by resin modified glass ionomer FUJI II LC and G Bond adhesive, while the highest microleakage was recorded in the EQUIA group. The two step self etch adhesive system demonstrated superior outcomes compared to the other groups.

To interpret these findings, differences in restorative materials and the structural characteristics of primary teeth must be considered. Microleakage can lead to marginal discoloration, bacterial penetration, secondary caries, and ultimately pulpal damage. Contributing factors include solubility, mismatch in thermal expansion coefficients, and polymerization shrinkage. Substrate characteristics may also influence outcomes, such as differences between coronal and radicular dentin, the presence or absence of enamel, variations in mineral content, and structural distinctions between primary and permanent teeth. For example, primary dentin exhibits reduced intertubular dentin, thicker peritubular dentin, and larger tubule diameter and density. Moreover, primary enamel shows higher resistance to etching systems. In pediatric patients, achieving proper isolation and using materials that allow faster application are critical.

The materials studied included two self etch adhesives combined with GC Gradia composite and two resin modified glass ionomers with high filler content. Self etch adhesives, by not completely etching the tooth surface and eliminating rinsing steps, preserve hydroxyapatite within the hybrid layer, enabling chemical bonding. This is particularly relevant for mild self etch systems, as used in this study, which can provide more durable bonding in dentin compared to total etch systems. The two step Clearfil Liner Bond F adhesive, containing 10 MDP monomer, forms a chemical bond with hydroxyapatite, reducing microleakage in both dentin and enamel. Although differences were not statistically significant, the results support this advantage. Since Clearfil Liner Bond F is relatively new, long term studies on its properties, especially in primary teeth, are limited. Its predecessor, Clearfil SE Bond, differs mainly in fluoride release, which is incorporated in Clearfil Liner Bond F.

The present study also demonstrated that microleakage at gingival margins was significantly higher than at occlusal margins, consistent with findings by Elsayed and Hammouda (2023). They emphasized that the absence of sufficient enamel at cervical margins and direct bonding to dentin are the main causes of increased microleakage. In contrast, occlusal margins bonded to enamel showed superior marginal sealing and restoration longevity. This convergence highlights the challenge of achieving stable bonding in cervical regions of Class V restorations in primary teeth.

Regarding resin modified glass ionomers (RMGICs), the findings align with Alsari et al. (2024), who reported that RMGICs exhibit greater resistance to microleakage due to dual acid–base and light curing reactions, along with fluoride release that reduces demineralization. Conventional GICs, however, demonstrated weaker marginal sealing due to mechanical limitations and moisture sensitivity. This comparison underscores the importance of structural modifications, such as resin incorporation and bioactive glass fillers, in reducing microleakage.

For resin composites, polymerization shrinkage remained the primary factor compromising marginal sealing, consistent with reports by Prabhakar et al. (2024) and Baldi et al. (2025). They also noted that high filler composites or nanoinomers can partially reduce shrinkage stress, yet cervical margins still exhibit higher microleakage. Thus, despite advances in composite technology, bonding challenges in cervical dentin persist, necessitating the development of novel adhesive systems with improved penetration into collagen fibrils.

CONCLUSION

Evaluation of microleakage at occlusal and gingival margins of EQUIA glass ionomer revealed no statistically significant differences compared to other groups. In pediatric dentistry, where isolation is difficult and treatment time must be minimized, bulk fill materials are advantageous. Considering the short initial setting time (3.5 minutes), ease of application, and antibacterial properties reported by Banava et al. (2012), EQUIA can be regarded as a practical and efficient option for restoring primary teeth.

Further studies are recommended, including extended thermocycling protocols, mechanical load testing, bond strength assessments, and in vivo investigations, to provide clearer evidence of the clinical effectiveness of this glass ionomer.

Limitations

The main limitation of this study was the lack of access to a dental bank and the difficulty in obtaining sound primary teeth for in vitro experiments.

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