

Original Research

Comparative Assessment of Microleakage in Class V Cavities Restored with Various Composite Resins: An In Vitro Study

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ABSTRACT:

Objective: The aim of this in vitro study was to assess and compare the microleakage in Class V cavities restored with different types of composite resins using a standardized dye penetration method. **Materials and Methods:** Sixty extracted human premolars were divided into four groups (n=15) and restored with microfilled, nanohybrid, bulk-fill, and flowable composites. Standardized Class V cavities were prepared and restored using a total-etch adhesive system. The specimens were subjected to 500 thermocycles, immersed in 0.5% methylene blue dye, sectioned, and evaluated under a stereomicroscope. Microleakage was scored using a 0–3 scale, and data were analyzed using one-way ANOVA and Tukey post hoc test (p<0.05). **Results:** The nanohybrid and bulk-fill composite groups exhibited significantly lower microleakage scores compared to the flowable group (p<0.05). Flowable composites showed the highest dye penetration, indicating poor marginal sealing. Microfilled composites had moderate leakage performance. **Conclusion:** Composite type significantly affects microleakage in Class V restorations. Nanohybrid and bulk-fill composites provided better marginal integrity, while flowable composites showed the highest leakage. Clinicians should consider material properties and cavity configuration when choosing restorative materials for cervical lesions.

Keywords: Microleakage, Class V cavity, Composite resin, Bulk-fill composite, Nanohybrid composite

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INTRODUCTION

Microleakage is a significant concern in restorative dentistry, particularly in Class V cavities where marginal adaptation is often compromised due to their cervical location. Defined as the passage of bacteria, fluids, molecules, or ions between the cavity wall and restorative material, microleakage can lead to postoperative sensitivity, marginal discoloration, recurrent caries, and eventual pulpal pathology [1]. The challenge in managing Class V lesions lies in their unique anatomical location, where bonding to both enamel and dentin is often required. Dentin bonding is inherently less predictable due to its higher organic content and tubular structure, increasing the risk of leakage [2].

Restorative materials and adhesive strategies continue to evolve, with composite resins becoming the material of choice for esthetic cervical restorations. Various types of composites are available, including microfilled, nanohybrid, flowable, and bulk-fill composites, each differing in viscosity, filler content, and polymerization shrinkage behavior [3]. These material characteristics directly influence their ability to achieve marginal seal and resist microleakage. For instance, flowable composites, though easier to adapt to cavity walls due to their low viscosity, may shrink more during polymerization, resulting in higher microleakage [4]. On the other hand, nanohybrid and bulk-fill composites are designed to reduce shrinkage stress and improve marginal integrity [5].

Bonding systems also play a crucial role in sealing Class V restorations. The effectiveness of total-etch versus self-etch adhesives in different dentin and enamel substrates has been widely studied, with varied results. The configuration factor (C-factor) of Class V cavities, which refers to the ratio of bonded to unbonded surfaces, further complicates polymerization shrinkage dynamics and the development of internal stress [6]. These stresses can result in debonding at the adhesive interface, promoting leakage.

Several in vitro studies have compared the sealing ability of different composites and bonding systems using methods such as dye penetration, fluid filtration,

MATERIALS AND METHODS

This in vitro study was conducted to evaluate and compare the microleakage of various composite resins in Class V cavities. A total of 60 freshly extracted human premolars, free from caries, cracks, and restorations, were collected and stored in 0.1% thymol solution until use. Each tooth was cleaned with an ultrasonic scaler to remove debris and soft tissue remnants.

Cavity Preparation

Standardized Class V cavities were prepared on the buccal surfaces of each tooth using a high-speed handpiece with a cylindrical diamond bur under constant water cooling. The cavity dimensions were approximately 3 mm mesiodistally, 2 mm occlusogingivally, and 2 mm deep. The occlusal margin was placed in enamel and the cervical margin in cementum or dentin to simulate clinical conditions. Burs were replaced after every five preparations to maintain uniformity.

Grouping of Samples: The 60 teeth were randomly divided into four groups (n=15 per group) based on the type of composite used:

Group I: Microfilled composite

Group II: Nanohybrid composite

Group III: Bulk-fill composite

Group IV: Flowable composite

Each group received a standardized etching and bonding protocol using a universal adhesive system (total-etch technique). A 37% phosphoric acid gel was applied for 15 seconds, rinsed, and air-dried. The adhesive was applied according to the manufacturer's instructions and light-cured for 20 seconds using an LED curing unit.

Each cavity was restored with the assigned composite resin, incrementally placed (for Groups I and II) or bulk-filled (for Group III) using a plastic instrument, followed by light-curing for 40 seconds. The restorations were then finished and polished with composite finishing kits.

Thermocycling and Microleakage Evaluation

The restored samples were subjected to **500 thermocycles** between 5°C and 55°C, with a dwell

and bacterial leakage tests [7]. Thermocycling and sectioning followed by stereomicroscopic analysis is a widely accepted protocol to simulate oral conditions and assess microleakage [8]. Despite advancements, no material has been shown to completely eliminate microleakage, underscoring the importance of comparative evaluations [9].

The present study aims to assess and compare the extent of microleakage in Class V cavities restored with different commercially available composites under standardized laboratory conditions. This research provides insights into selecting the most suitable material to ensure long-term success of cervical restorations [10].

time of 30 seconds in each bath to simulate oral temperature variations. After thermocycling, the root apices were sealed with composite resin, and all tooth surfaces were coated with two layers of nail varnish, except for a 1 mm window around the restoration margin.

Samples were immersed in 0.5% methylene blue dye for 24 hours at 37°C, then rinsed, sectioned buccolingually through the center of the restoration using a diamond disc under water coolant. The sectioned specimens were examined under a stereomicroscope at 40x magnification.

Scoring Criteria

Microleakage was evaluated using the following scoring system:

- **Score 0:** No dye penetration
- **Score 1:** Dye penetration up to one-third of the cavity depth
- **Score 2:** Dye penetration up to two-thirds of the cavity depth
- **Score 3:** Dye penetration along the entire cavity wall

Statistical Analysis

The data were entered into Microsoft Excel and analyzed using SPSS software version 24.0. Mean microleakage scores were calculated for each group. One-way Analysis of Variance (ANOVA) was applied to assess differences among the groups. A post hoc Tukey test was used for pairwise comparisons. A p-value of <0.05 was considered statistically significant.

RESULTS

The extent of microleakage for each group was assessed and scored based on dye penetration. The mean microleakage scores and standard deviations for each group are presented in **Table 1. Microleakage scores** varied significantly among the different composite materials. The **nanohybrid composite group (Group II)** showed the least dye penetration (mean score: 0.93 ± 0.59), followed closely by the **bulk-fill group (Group III)** (1.00 ± 0.65). The **flowable composite group (Group IV)** had the highest leakage (2.27 ± 0.70), while the **microfilled**

group (Group I) showed moderate leakage (1.80 ± 0.77). ANOVA analysis confirmed significant differences among groups ($p < 0.05$). Graph 1

The **flowable composite group (Group IV)** exhibited the highest mean microleakage score, indicating poor marginal sealing. In contrast, **nanohybrid composite (Group II)** and **bulk-fill composite (Group III)** demonstrated significantly lower microleakage values, suggesting better adaptation and sealing ability. The **microfilled composite group (Group I)** showed intermediate leakage performance.

The **Tukey post hoc test** (Table 2) revealed a statistically significant difference in microleakage between Group II and Group IV ($p = 0.001$) and between Group III and Group IV ($p = 0.002$). No statistically significant difference was noted between Groups II and III or between Groups I and III. graph 2 These findings indicate that the **type of composite resin used has a significant effect on the degree of microleakage in Class V restorations**, with nanohybrid and bulk-fill composites providing superior marginal integrity under in vitro conditions.

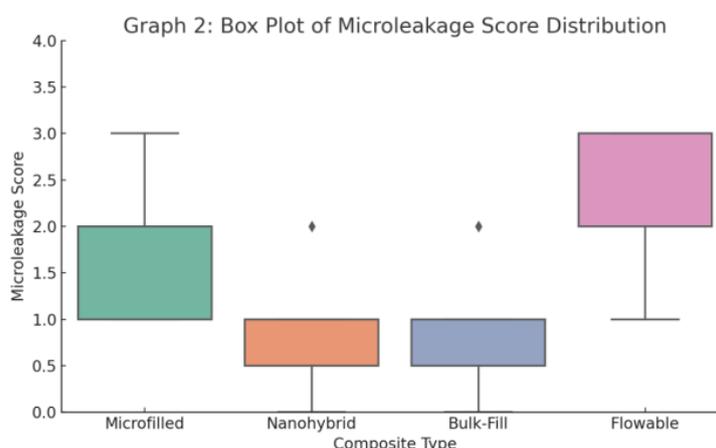
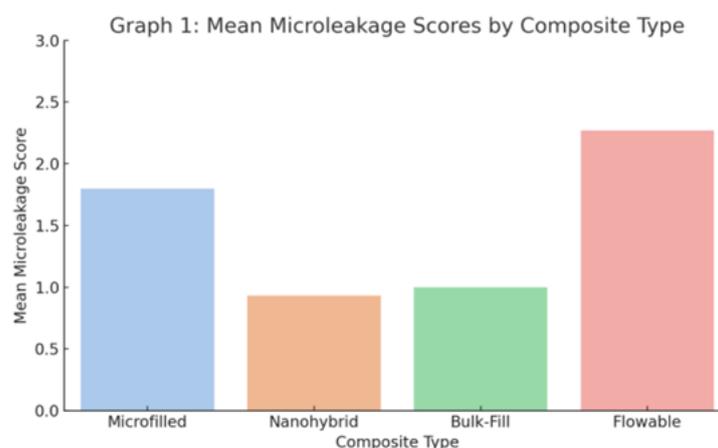
Table 1: Comparison of Mean Microleakage Scores Among Groups

Group	Type of Composite	Mean Score \pm SD	ANOVA p-value
Group I	Microfilled Composite	1.80 ± 0.77	
Group II	Nanohybrid Composite	0.93 ± 0.59	
Group III	Bulk-Fill Composite	1.00 ± 0.65	<0.05
Group IV	Flowable Composite	2.27 ± 0.70	

Table 2: Intergroup Comparison (Tukey Post Hoc Test)

Group Comparison	Mean Difference	p-value
Group I vs Group II	0.87	0.078
Group I vs Group III	0.80	0.092
Group I vs Group IV	-0.47	0.039*
Group II vs Group III	0.07	0.983
Group II vs Group IV	-1.34	0.001*
Group III vs Group IV	-1.27	0.002*

*Statistically significant



DISCUSSION

Microleakage continues to be a major concern in restorative dentistry, particularly in Class V cavities where the cervical margin often lies in dentin or cementum. This study aimed to assess and compare the microleakage associated with different composite resins using a standardized in vitro dye penetration model. The results revealed statistically significant differences among the groups, highlighting the influence of composite type on marginal sealing ability.

The **nanohybrid composite group** showed the least microleakage, which can be attributed to its balanced filler load, optimal viscosity, and lower polymerization shrinkage stress [1]. Nanohybrid resins typically contain nanometric fillers and a well-distributed resin matrix, which improves both mechanical strength and adaptability to cavity walls [2]. In contrast, **flowable composites**, despite their ease of placement, exhibited the highest microleakage scores. This may be explained by their lower filler content and increased resin volume, which heightens polymerization contraction and reduces marginal adaptation [3,4].

Bulk-fill composites, which are designed to be placed in increments up to 4 mm due to modified resin matrices and optimized filler technology, demonstrated favorable performance in this study. Their lower shrinkage stress and improved depth of cure make them suitable for deeper restorations, as seen in Class V cavities [5]. Several studies have reported reduced microleakage in bulk-fill composites compared to conventional types, supporting the present findings [6].

The **microfilled composite** group showed intermediate leakage performance. While these composites offer excellent polishability and esthetics, their lower filler load may compromise marginal sealing in high-stress areas such as the cervical margin [7]. Moreover, the bond strength at the cervical margin is often weaker due to the absence of enamel, contributing to leakage in this region regardless of the composite type [8].

The bonding strategy used also significantly influences the sealing ability. In this study, a total-etch adhesive protocol was used for standardization. Previous literature has shown that total-etch systems

provide higher bond strength in enamel but may be sensitive to over-etching and over-drying when applied on dentin [9,10]. Conversely, self-etch adhesives minimize post-operative sensitivity but may compromise bond durability in enamel-rich areas [11]. Another critical factor is the **configuration factor (C-factor)** of the cavity. Class V restorations have a high C-factor, meaning that there is a larger ratio of bonded to unbonded surfaces. This creates stress during polymerization, which can lead to debonding and microleakage if not managed properly [12]. Incremental placement techniques and the use of

materials with lower shrinkage stress, such as bulk-fill and nanohybrid composites, are recommended to mitigate this issue [13].

While this study was conducted under standardized laboratory conditions, it does not fully replicate the complex oral environment. The absence of saliva, masticatory forces, and bacterial flora limits the external validity of the results [14]. Nevertheless, dye penetration remains one of the most commonly used and validated methods for evaluating microleakage in vitro due to its simplicity and sensitivity [15].

CONCLUSION

This in vitro study demonstrated that the type of composite resin significantly influences microleakage in Class V cavities. Among the tested materials, nanohybrid and bulk-fill composites exhibited superior marginal sealing, likely due to their optimized filler content, reduced polymerization shrinkage, and better adaptability to cavity walls. Microfilled composites showed moderate leakage, while flowable composites had the highest dye penetration, indicating poor sealing capacity. Given the high C-factor and complex stress dynamics of Class V lesions, the choice of restorative material plays a crucial role in clinical success. These findings suggest that selecting appropriate composite resins can reduce microleakage and enhance the longevity of cervical restorations. Further in vivo studies are recommended to confirm these outcomes under functional oral conditions.

REFERENCES

1. Shenoj PR, Kokane VB, Thawale HV, Kubde RR, Gunwal MK, Shahu SP. Comparing marginal microleakage in Class V cavities restored with flowable composite and Cention-N using confocal microscope—an in-vitro study. *Indian J Dent Res.* 2021;32(3):348–53.
2. Sengar EV, Mulay S, Beri L, Gupta A, Almohareb T, Binalrimal S, et al. Comparative evaluation of microleakage of flowable composite resin using etch and rinse, self-etch adhesive systems, and self-adhesive flowable composite resin in Class V cavities: Confocal laser microscopic study. *Materials (Basel).* 2022;15(14):4963.
3. Fathpour K, Bazazzade A, Mirmohammadi H. A comparative study of cervical composite restorations microleakage using dental universal bonding and two-step self-etch adhesive. *J Contemp Dent Pract.* 2021;22(9):1035–40.
4. Valizadeh S, Hashemi SF, Hashemikamangar SS, Kharazifard MJ. Microleakage of a self-adhesive composite of Class V cavities: Effect of surface treatment and thermocycling. *J Contemp Dent Pract.* 2020;21(7):781–6.
5. Alshehri N, Aljamhan A, Bin-Shuwaish M. The effects of amalgam contamination and different surface modifications on microleakage of dentin bonded to bulk fill composite when using different adhesive protocols. *BMC Oral Health.* 2022;22(1):186.

6. Bajabaa S, Balbaid S, Taleb M, Islam L, Elharazeen S, Alagha E. Microleakage evaluation in Class V cavities restored with five different resin composites: In vitro dye leakage study. *ClinCosmetInvestig Dent.* 2021;13:405–11.
7. Biradar N, Allappanavar KS, Shetty NK, Patil BS, Hegde RS, Moogi P. Evaluation of marginal adaptation of composite restorations reinforced with novel enamel inserts (biofillers) in Class V cavities. *J Contemp Dent Pract.* 2020;21(12):1368–73.
8. Gupta N, Singh N. Restorations of Class II cavities evaluated for marginal leakage when restored with composites or a giomer using different bonding agents. *Int J Periodontics Restorative Dent.* 2023;43(7):s129–s145.
9. Sujith R, Yadav TG, Pitalia D, Babaji P, Apoorva K, Sharma A. Comparative evaluation of mechanical and microleakage properties of Cention-N, composite, and glass ionomer cement restorative materials. *J Contemp Dent Pract.* 2020;21(6):691–5.
10. Venugopal K, Krishnaprasad L, V P PS, Ravi AB, Haridas K, Soman D. A comparative evaluation of microleakage between resin-modified glass ionomer, flowable composite, and Cention-N in Class V restorations: A confocal laser scanning microscope study. *J Pharm Bioallied Sci.* 2021;13(Suppl 1):S132–6.
11. Kumari A, Singh N. A comparative evaluation of microleakage and dentin shear bond strength of three restorative materials. *BiomaterInvestig Dent.* 2022;9(1):1–9.
12. Tohidkhalah S, Kermanshah H, Ahmadi E, Jalalian B, RanjbarOmrani L. Marginal microleakage and modified microtensile bond strength of Activa Bioactive, in comparison with conventional restorative materials. *ClinExp Dent Res.* 2022;8(1):329–35.
13. Shim JS, Li CY, Won JE, Ryu JJ. Evaluation of microleakage and push-out bond strength of various composite resins for sealing the screw-access channel in implant-supported restorations. *J Prosthet Dent.* 2022;128(4):764.e1–e7.
14. Harp YS, Montaser MA, Zaghoul NM. Flowablefiber-reinforced versus flowable bulk-fill resin composites: Degree of conversion and microtensile bond strength to dentin in high C-factor cavities. *J EsthetRestor Dent.* 2022;34(4):699–706.
15. Alshehri N, Aljamhan A, Bin-Shuwaish M. The effects of amalgam contamination and different surface modifications on microleakage of dentin bonded to bulk fill composite when using different adhesive protocols. *BMC Oral Health.* 2022;22(1):186.