Innovative Research Journal of **Dentistry** (IRJD)
2025; 3(1):9-16
DOI: https://doi.org/10.62497/irjd.151

INNOVATIVE RESEARCH JOURNALS

Research Article

Comparative Analysis of Composite Resin and Glass Ionomer Cement in Pediatric Restorative Dentistry

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Citation: Zehra DB, Shakoor MU, Akbar DP, Sattar S, Imtiaz K. Comparative Analysis of Composite Resin and Glass Ionomer Cement in Pediatric Restorative Dentistry. Innov. Res. J. Dent. 2025;3(1):9-16. Available from: https://irjpl.org/irjd/article/view/151

Article Info

Received: April 17, 2025
Revised: May 3, 2025
Accepted: May 11, 2025

Keywords

composite resin, glass ionomer cement, GIC, pediatric dentistry, primary molars, dental caries, restorative materials, clinical evaluation

Abstract

Introduction: Restorative management of dental caries in children requires materials that ensure durability, esthetics, and ease of application. Composite resin and glass ionomer cement (GIC) are commonly used in pediatric dentistry, yet their clinical performance remains a topic of comparison. **Objective:** To compare the clinical outcomes of composite resin and glass ionomer cement in class I and II restorations of primary molars in children over a 12-month period. **Methodology:** This comparative longitudinal study was conducted at Khyber College of Dentistry, Peshawar, over 12 months. A total of 120 children aged 5–10 years were enrolled, receiving 60 restorations each of composite resin and GIC. Restorations were evaluated at 3, 6, and 12 months using modified USPHS criteria, assessing retention, marginal adaptation, surface roughness, color match, and overall success. Statistical analysis was performed using SPSS version 26, with chi-square and independent t-tests applied. A p-value <0.05 was considered significant. **Results:** Composite resin showed significantly better retention at 6 and 12 months ($p = 0.044$, $p = 0.014$), superior marginal adaptation ($p = 0.013$), and improved surface and esthetic qualities ($p < 0.01$). It also exhibited fewer failures, smoother surfaces, and better color stability. Overall success was higher in the composite group (91.7%) compared to GIC (75.0%) with fewer failures ($p = 0.021$). **Conclusion:** Composite resin demonstrated superior clinical performance compared to GIC in pediatric molar restorations over 12 months. It is recommended as the material of choice where moisture control and technique allow.

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Introduction

Dental caries remains one of the most prevalent chronic conditions affecting children worldwide, with a significant impact on general health, development, and quality of life [1]. Caries in primary teeth may be a significant cause of loss of arch length, malocclusion, speech disorders, and impaired self-esteem because the primary teeth are prematurely lost [2]. To avoid these kinds of problematic outcomes, proper treatment of carious lesions in children patients is necessary to guarantee the best results in oral health outcomes [3]. Among the various treatment modalities, restorative procedures play an important role in halting disease progression and restoring the form and function of affected teeth [4].

The restorative material used in pediatric restorative dentistry has to be able to fit the requirements of the dynamic oral atmosphere, aesthetic gratification, bond to both enamel and dentin as well as withstanding grinding forces [5]. Two popular dental instruments in the medical profession are Composite resin (CR) and Glass Ionomer Cement (GIC). Composite resins are widely recognized for their superior esthetic properties, high compressive strength, and strong adhesion to tooth structure, especially when used with an appropriate adhesive system. [6].

These methods have limitations of sensitivity, capacity to lead to contraction of the polymerization, and requirement to exert a lot of restrictions on the moisture environment and do not work in young children [7]. On the other hand, glass ionomer cements have been appreciated owing to the chemical adherence to enamel and dentin, ease of administration, biocompatibility, and above all the fluoride-release quality, which also helps in secondary prevents caries [8]. Their relatively rapid set time and their capacity to be put into a moist environment makes them especially helpful among the pediatric patient because of the restricted collaborative ability of the patient in question [9].

GICs have received critic as they are comparatively weaker and less wear resistant making it of weaker durability in areas of high stress [10]. Many clinical comparisons between the performances of such materials have been published, and the parameters have been notes and monitored to include retention rate, marginal integrity, surface roughness, color stability, and the incidence of caries recurrence [11]. Although the literature on the topic is increasing, there is still no clinical consensus, particularly in pediatrics, where behavior, cavity size/location, oral hygiene conditions, and caries risk may play a pivotal role in determining the results [12].

The current evolution of material formulations on the one hand in resin-modified GICs and, on the other hand in nanohybrid composites means that updated comparative studies against each other under standardised conditions should take place [13]. There is not much conclusive evidence on the long-term clinical efficacy of the composite resin and glass ionomer cement when used in children under normal clinical conditions. This paper will thus compare and contrast the use of composite resin and glass ionomers cement on restorative dentistry treatment on the pediatrics, its effectiveness, durability and the outcome of the patient to whom the procedure is done.

Materials and Methods

Study Design and Setting: This comparative longitudinal study was conducted in the Department of Pediatric Dentistry at Khyber College of Dentistry (KCD), Peshawar. The study duration was 12 months, spanning from 15 March 2022 to 15 March 2023.

Sample Size Calculation: A total of 120 pediatric patients were included in the study. The sample size was calculated using OpenEpi software, considering a confidence level of 95%, power of 80%, and an expected difference in failure rates between the two materials of 20%. The minimum required sample size per group was 55; to accommodate potential loss to follow-up, this was increased to 60 restorations in each group, resulting in a total of 120 cases (60 composite resin and 60 GIC).

Inclusion and Exclusion Criteria: Children aged between 5 and 10 years were included in the study if they presented with at least one class I or class II carious lesion in a primary molar without clinical or radiographic signs of pulpal involvement. Only children demonstrating cooperative behavior, classified as Frankl rating 3 or 4, and those without any systemic diseases or conditions affecting oral health were eligible. Exclusion criteria included teeth with extensive decay involving the pulp, patients with known allergies to dental materials, children undergoing orthodontic treatment, and those who were lost to follow-up during the study period.

Clinical Procedure: Eligible teeth were evaluated clinically and radiographically. Cavity isolation was performed using cotton rolls in combination with high-volume suction to maintain a dry working field. In the composite resin group, the cavity was etched using 37% phosphoric acid, followed by application of a bonding agent and incremental placement of light-cured resin composite. In the glass ionomer cement group, a high-viscosity conventional GIC was used, preceded by cavity conditioning with polyacrylic acid.

Restorations were finished and polished using fine discs and rubber points. Occlusion was checked in all cases. Follow-up evaluations were conducted at 3, 6, and 12 months post-restoration.

Evaluation Criteria: Each restoration was evaluated using the modified United States Public Health Service (USPHS) criteria, which assessed five key parameters: retention, marginal adaptation, secondary caries, surface roughness, and color match. Each criterion was scored as Alpha (ideal), Bravo (clinically acceptable), or Charlie (clinically unacceptable/failure). A restoration was considered failed if it received a Charlie rating in any of the assessed categories.

Data Analysis: Data were analyzed using SPSS version 26. Descriptive statistics, including means, standard deviations, and frequencies, were calculated. Categorical variables were compared using the chi-square test, and continuous variables were analyzed using independent t-tests. Multiple comparison adjustments (e.g., Bonferroni correction) were not applied, as the primary outcomes were pre-specified and hypothesis-driven. A p-value <0.05 was considered statistically significant.

Ethical Considerations: Ethical approval was obtained from the Institutional Ethical Review Committee of Khyber College of Dentistry, Peshawar. Informed written consent was obtained from the parents or guardians of all participants. The study was conducted in accordance with the Declaration of Helsinki.

Results

A total of 120 restorations were evaluated 60 in Group A (Composite Resin) and 60 in Group B (Glass Ionomer Cement). Patients were followed up at 3, 6, and 12 months, and restorations were assessed using modified USPHS criteria, focusing on retention, marginal adaptation, surface roughness, color match, and overall success or failure. As shown in Table 1, the two groups were comparable in terms of demographic characteristics. The mean age in Group A was 7.5 ± 1.5 years, while in Group B it was 7.3 ± 1.7 years, showing no statistically significant difference ($t = 0.795$, $p = 0.428$). Gender distribution was nearly equal, with 32 males and 28 females in Group A, and 30 males and 30 females in Group B, which also revealed no significant difference ($\chi^2 = 0.137$, $p = 0.713$). The average number of restorations per child was slightly higher in the composite group (1.2 ± 0.4) compared to the GIC group (1.1 ± 0.5), though this difference was not statistically significant ($t = 1.122$, $p = 0.267$). These comparable baseline characteristics confirm the randomization effectiveness and support that differences in outcomes are due to the restorative materials rather than demographic variability, thereby enhancing the internal validity of the study.

Table 1: Demographic Characteristics of Study Participants

Variable	Group A (Composite Resin)	Group B (GIC)	Test Used	Test Value	p-value
Number of Patients	60	60			
Mean Age (years)	7.5 ± 1.5	7.3 ± 1.7	Independent t-test	t = 0.795	0.428
Gender (Male/Female)	32/28	30/30	Chi-square test	$\chi^2 = 0.137$	0.713
Average Restorations per Child	1.2 ± 0.4	1.1 ± 0.5	Independent t-test	t = 1.122	0.267

As illustrated in Figure 1, the retention rate of composite resin restorations was consistently higher than that of GIC at all follow-up intervals. At 3 months, both materials showed high retention with no statistically significant difference ($\chi^2 = 1.39$, $p = 0.238$). However, at 6 months, retention in the GIC group dropped to 81.7% compared to 93.3% in the composite group ($\chi^2 = 4.03$, $p = 0.044$), indicating a significant difference. This gap widened further at 12 months where only 70% of GIC restorations were retained versus 88.3% in the composite group ($\chi^2 = 6.01$, $p = 0.014$). These results support the superior adhesive and mechanical durability of composite resin over time in pediatric settings.

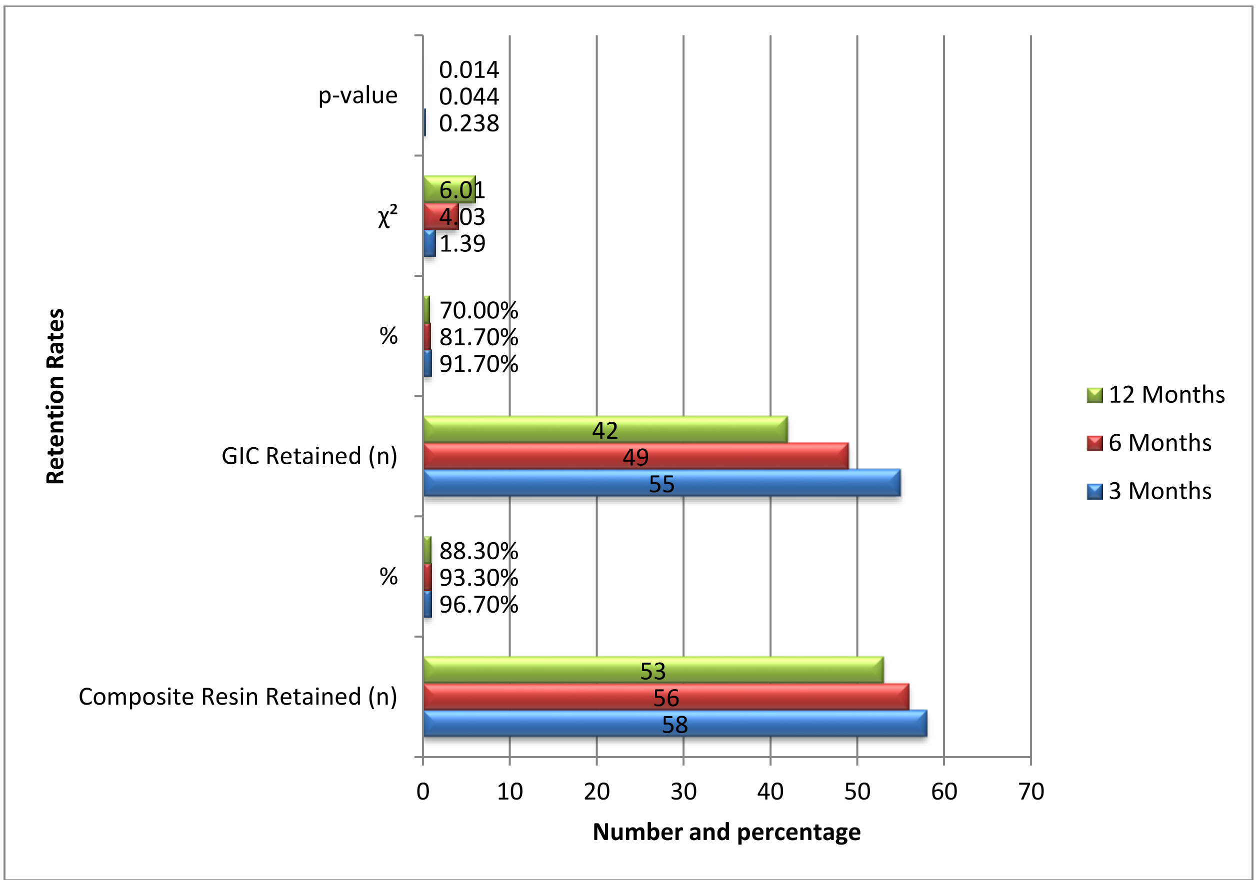

Figure 1: Retention Rates at 3, 6, and 12 Months.

Retention rates of composite resin and glass ionomer cement restorations at 3, 6, and 12 months. Values are expressed as percentages of restorations *retained in each group (n = 60 per group).*

Figure 2 shows that composite resin restorations had better marginal adaptation than GIC at 12 months. In the composite group, 80% of restorations were rated Alpha, compared to 58.3% in the GIC group. Failures (Charlie ratings) were lower in the composite group (3.3%) than in GIC (11.7%).The chi-square test confirmed a significant difference in marginal integrity (χ^2 = *8.66, p = 0.013*). This finding reflects composite resin's superior ability to resist marginal breakdown and microleakage over time. GIC's relatively poorer marginal adaptation may be linked to its lower compressive strength and greater wear in clinical function.

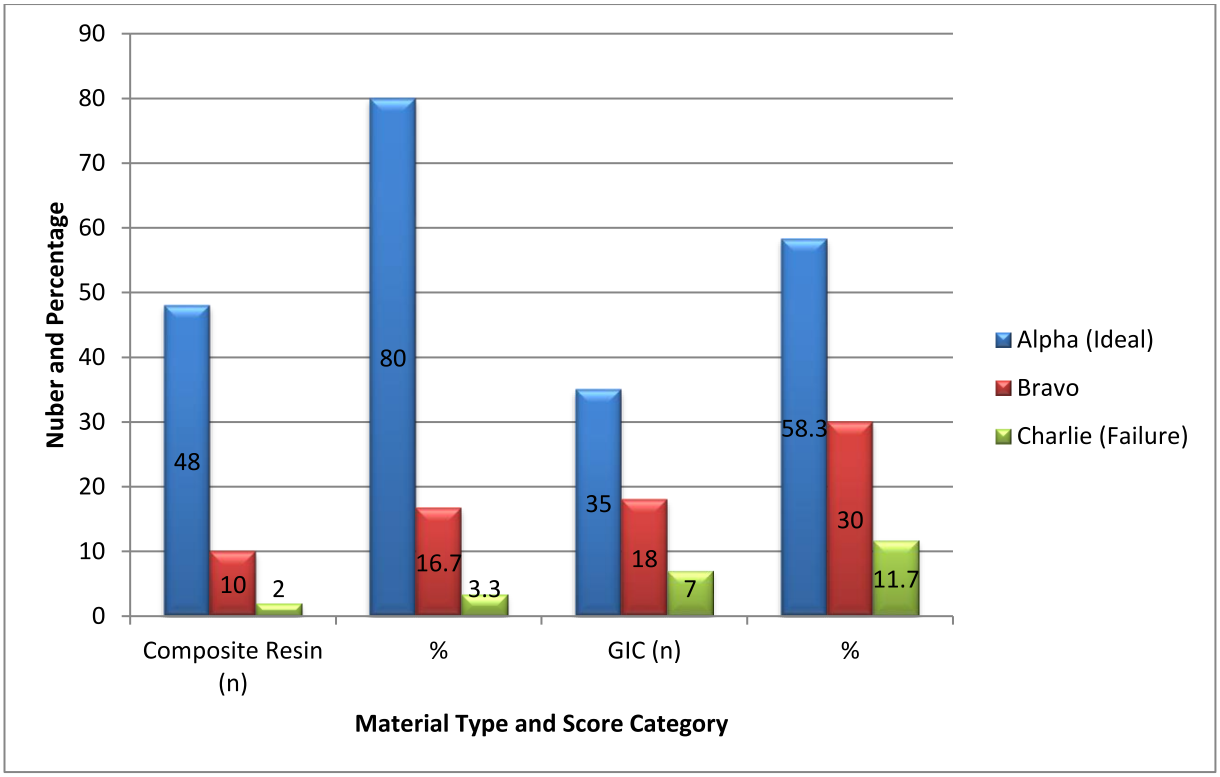

Figure 2: Marginal Adaptation (USPHS Scores at 12 Months)
Marginal adaptation of composite resin and glass ionomer cement restorations at 12 months. Restorations were evaluated using modified USPHS criteria and scored as Alpha (ideal), Bravo (clinically acceptable), or Charlie (failure). Values represent the percentage of restorations in each category for both groups (n = 60 per group).

As shown in Table 2, composite resin showed significantly superior performance in both surface roughness and color match at 12 months. In terms of surface texture, 76.7% of composite restorations were rated Alpha, whereas only 48.3% of GIC restorations achieved the same grade (χ^2 = *12.02, p = 0.002*). Similarly, 75% of composite restorations had excellent color match compared to 50% of GIC (χ^2 = *10.48, p = 0.005*). The higher frequency of Bravo and Charlie scores in the GIC group suggests greater susceptibility to roughness and discoloration. These outcomes may reflect composite resin's superior polishability, esthetic properties, and color stability. In contrast, GIC's porous structure and susceptibility to moisture during setting may contribute to inferior esthetic outcomes.

Table 2: Surface Roughness and Color Match at 12 Months

Evaluation Criteria	Score	Composite Resin	GIC	Test Used	χ^2	p-value
Surface	Alpha	46 (76.7%)	29(48.3%)			

Roughness	Bravo	11 (18.3%)	23 (38.3%)	Chi-square test	12.02	0.002
	Charlie	3 (5.0%)	8 (13.3%)			
Color Match	Alpha	45 (75.0%)	30 (50.0%)			
	Bravo	12 (20.0%)	22 (36.7%)	Chi-square test	10.48	0.005
	Charlie	3 (5.0%)	8 (13.3%)			

As shown in Table 3, the composite resin group had a significantly higher overall success rate compared to the GIC group after 12 months. Success was defined as restorations scoring Alpha or Bravo across all USPHS criteria. Composite resin achieved a 91.7% success rate, while GIC had only 75.0% ($\chi^2 = 5.29$, $p = 0.021$). Conversely, failure (Charlie score) occurred in 25% of GIC restorations versus just 8.3% in composite. These findings strongly suggest the clinical superiority of composite resin in terms of longevity and overall performance. They align with its better scores in marginal adaptation, retention, esthetics, and surface quality.

Table 3: Overall Restoration Success and Failure at 12 Months

Outcome	Composite Resin (n)	%	GIC (n)	%	Test Used	χ^2	p-value
Success (Alpha/Bravo only)	55	91.7	45	75.0	Chi-square test	5.29	*0.021*
Failure (Charlie score)	5	8.3	15	25.0			

Discussion

The results of this study revealed that composite resin restorations performed significantly better than glass ionomer cement (GIC) restorations in pediatric patients over a 12-month follow-up period. Composite resin showed higher retention rates, superior marginal adaptation, smoother surface texture, and better color stability. Overall success was significantly greater in the composite group, with fewer restorations failing across all evaluation parameters. GIC, while still clinically acceptable in many cases, demonstrated more failures in marginal integrity, surface roughness, and esthetic outcomes.

When comparing these findings with existing literature, the results are consistent with studies that emphasize the superior mechanical properties of composite resins. These include higher compressive and tensile strength, better wear resistance, and superior polish ability [14]. In multiple clinical trials, composite restorations have shown longer survival rates in both anterior and posterior restorations in pediatric patients, especially when proper moisture control is maintained [15].

Glass ionomer cement, although widely favored for its ease of use, fluoride release, and chemical bonding to tooth structure, consistently performs less favorably in long-term studies [16]. Its vulnerability to occlusal stress, moisture sensitivity during the initial setting phase, and surface degradation contribute to its reduced longevity [17]. Some in-vitro and in-vivo studies have reported significantly higher wear rates and marginal breakdown in GIC compared to composite resins after 6–12 months, supporting our findings [18]. Moreover, esthetic parameters such as color match and surface gloss are often compromised in GIC due to its granular consistency and lack of resin content, aligning with the lower Alpha ratings observed in this study [19].

Despite their advantages, the clinical success of composite restorations largely depends on proper isolation and patient cooperation. The placement technique is more sensitive, requiring etching, bonding, and incremental curing [20]. However, in this study, all procedures were conducted by experienced clinicians under controlled conditions, which may have contributed to the high success rate of composite resin [21].

Limitations and Future Suggestions

This study had a few limitations. The follow-up duration was limited to 12 months, which may not capture long-term restoration failures. The study setting was a single tertiary care center with experienced operators, which may not reflect outcomes in general practice. Additionally, patient-related variables such as diet, oral hygiene, and occlusal load were not controlled in detail, which could influence restoration longevity.

Future research should include multi-center trials with longer follow-up periods to evaluate long-term performance. Investigating newer GIC variants such as resin-modified and nano-filled glass ionomers may also provide a more comprehensive understanding of their comparative effectiveness. Further studies involving cost-effectiveness analysis, patient satisfaction, and operator ease may also help guide material selection in pediatric restorative dentistry.

Conclusion

This study demonstrated that composite resin significantly outperforms glass ionomer cement in terms of clinical success, retention, marginal adaptation, esthetics, and overall durability in pediatric restorative dentistry over a 12-month period. While GIC remains a useful material in cases requiring simplicity and fluoride release, composite resin is a more reliable option for long-term restorations when proper technique and isolation can be ensured. These findings support the preferential use of composite resin in primary molar restorations to achieve better functional Final approval of the version to be published: All authors.

and esthetic outcomes in children.

List of Abbreviations

χ^2: Chi-square test
t: Independent t-test
p: Probability value
USPHS: United States Public Health Service
GIC: Glass Ionomer Cement

Declarations

Acknowledgements

The authors would like to thank the faculty and staff of Khyber College of Dentistry, Peshawar, for their support during the conduct of this study. Special appreciation is extended to the participants and their families for their cooperation.

Conflict of Interest / Competing Interests

The authors declare that there are no conflicts of interest or competing interests related to this study.

Ethics Approval

Ethical approval for this study was obtained from the Institutional Ethical Review Committee of Khyber College of Dentistry, Peshawar. The study was conducted in accordance with the Declaration of Helsinki.

Funding

Nil.

Patient Consent

Informed written consent was obtained from the parents or legal guardians of all participants prior to inclusion in the study.

Authors' Contributions

Concept and design of the study: US
Drafting of the manuscript: BZ, PA, SS
Data analysis: PA, SS, KI
Critical revision of the manuscript for important intellectual content: US, BZ

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