Beyond Amalgam: Evaluating the Clinical Efficacy of Two Glass Ionomer Cements in Managing Dental Caries

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ABSTRACT
Background: Concerns about dental amalgam safety led to interest in alternatives like glass ionomer cements (GICs).
Objective: This study evaluated and compared the clinical performance of two different GIC compositions, Type II and Type IX, in managing dental caries.
Methods: This randomized clinical trial compared the performance of two distinct glass ionomer cement (GIC) formulations in managing dental caries. The study involved 16 patients with 48 affected teeth, which were randomly assigned to receive either Type II or Type IX GIC restorations using a split-mouth design. Two independent, blinded examiners evaluated the restorations at baseline, 1 month, and 3 months using a modified version of the USPHS criteria. Inter-examiner reliability was assessed using kappa statistics. Statistical analysis was performed using IBM SPSS 26.0 software, employing Fisher's exact test, Pearson's chi-square test, descriptive statistics, and McNemar's test to analyze the data
Results: The study participants consisted of 16 individuals with 48 teeth. All 24 matched tooth pairs were correctly identified in terms of the side of the mouth. The arch was also correctly identified in 95.8% of cases, with only one incorrect match. Five clinical criteria: retention, marginal integrity, anatomic form, sensitivity, and surface texture recorded changes across both GICs, while marginal discolouration and secondary caries demonstrated stable and favourable outcomes throughout the evaluation period. Overall, the results indicate that Type IX consistently showed a higher proportion of acceptable outcomes across most criteria, outperforming Type II over time, however, this was not statistically significant.
Conclusion: Both Type IX and Type II Glass Ionomer Cements (GICs) have demonstrated exceptional clinical efficacy and longevity in dental restorations. A comparative analysis revealed no statistically significant differences in performance between these two GIC formulations.
Keywords: Glass Ionomer Cement (GIC); Dental Restorations; Clinical Performance; Dental caries; Dental materials

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INTRODUCTION

Poor oral health has far-reaching consequences, impacting not only an individual's quality of life but also their overall well-being. Dental caries, a pervasive and debilitating condition, affects nearly 100% of the global population, with its prevalence varying by age, gender, and socioeconomic status.[1,2]
The World Health Organization (WHO) has identified dental caries as the most common non-communicable disease worldwide, underscoring the need for effective prevention and management strategies.[2]

Worldwide dental caries prevalence is high among adults as the disease affects nearly 100% of the population in majority of countries.[1] In developing economies, such as Nigeria, dental caries remains a significant public health concern. The lack of access to preventive dental care, combined with limited resources and infrastructure, exacerbates the problem. As a result, there is a pressing need for affordable, effective, and minimally invasive treatments that can be easily integrated into existing healthcare systems.

For centuries, amalgam has been the preferred material for restoring posterior teeth with cavities, thanks to its proven safety, durability, and affordability.[3] However, concerns over its mercury content have sparked global efforts to phase down its use. Mercury, a known neurotoxin, can be released as vapor during placement or removal, raising potential health risks, especially in vulnerable populations. Environmental concerns also play a major role due to the potential for mercury contamination through dental office waste. In response to these concerns, international treaties like the Minamata Convention on Mercury have called for a phase-down of amalgam usage.[4] Additionally, the World Dental Association (FDI) and the World Health Organization (WHO) have emphasized the development and adoption of alternative materials that are biocompatible, mercury-free, and support minimally invasive dentistry.[5,6]

In response to these concerns, glass ionomer cements (GICs) have emerged as a viable alternative. GICs offer a unique combination of biocompatibility, bioactivity, and long-term fluoride release, making them an attractive option for restoring carious and non-carious lesions.[7,8] Their ability to adhere to moist enamel and dentin without intermediate materials further enhances their appeal.[9]

Since their introduction by Kent and Wilson in the 1970s ,[10] GICs have undergone several modifications and improvements,[11] resulting in various compositions. Two notable compositions are Type II and Type IX GICs. Type II GIC is a restorative glass ionomer cement, used for cavity restoration, containing a powdered glass ionomer and an acidic liquid. It offers strong adhesion to enamel and dentin, and higher compressive strength than Type I GIC. In contrast, Type IX GIC was specifically developed for geriatric and pediatric patients and was introduced to clinical practice in the late 1990s. It is a strontium-based glass ionomer cement that promotes remineralization of the tooth structure, exhibits chemical adhesion to enamel and dentin, and releases fluoride to prevent caries. Type IX GIC also possesses high strength, wear resistance, radioopacity, and less technique sensitivity to saliva.[12] Additionally, it is highly viscous, condensable, and has better esthetics due to the reduction in glass particle size, allowing for a faster reaction between silica particles and polyacrylic acid.[13] Notably, Type IX GIC is more expensive than Type II GIC, raising questions about its relative effectiveness.

In Nigeria, amalgam remains the primary material for posterior teeth restoration, despite its drawbacks. However, several studies[7,14-16] have explored alternative compositions of Glass Ionomer Cements (GICs) as a potential replacement. These compositions vary in cost, technique sensitivity, and performance. Given the disparities in oral healthcare across Nigeria, it is essential to identify a suitable material for use in rural settings with limited equipment. Additionally, the difference in diet and dietary habits between Caucasians and Nigerians necessitates evaluating materials specifically for the Nigerian population.

Furthermore, the clinical performance of GICs in managing dental caries has been understudied in Nigeria. The longevity of a restoration is a key indicator of a dental treatment's effectiveness.[17] Although previous research has focused on composite formulations,[18] studies on GICs are scarce. Moreover, conflicting evidence exists on GICs' clinical performance and longevity compared to other materials.[19]

This study aims to evaluate and compare the clinical performance of two specific compositions of Glass Ionomer Cements (GICs), Type II and Type IX, as viable alternatives to amalgam in managing dental caries in adults.

MATERIALS AND METHODS

This research was undertaken at the Conservation Unit, Department of Restorative Dentistry, University of Benin Teaching Hospital (UBTH), Benin-City, Edo State, Nigeria. The study received ethical clearance from the University of Benin Teaching Hospital's Ethics and Research Committee. Prior to participation, all recruited patients provided written informed consent, having been fully apprised of the study's details. Participants were assured that involvement was entirely voluntary and that they were free to withdraw from the study at any point

This was a randomized comparative longitudinal clinical study of patients with proximal and occlusal carious lesions. The study was a double-blind study (dentists/operator and evaluator). The split mouth technique was used. Simple randomization technique was used to determine the side of the mouth that will receive which restorative material. Participants were required to pick a prelabelled card from a bag. Even numbers represented type IX GIC and odd numbers represented type II GIC. The participants were required to pick prelabelled cards to determine which side the GIC will be placed. 1 represented the right side and 2 represented the left side. Even number and 1 denotes GIC type IX on the right side while the type II will automatically be placed on the left side.

Inclusion criteria: Participants with low caries index who had at least two posterior teeth with proximal or occlusal carious lesions, each graded as ICDAS codes 3 and 4, with a contralateral counterpart present. Opposing teeth to the tooth to be restored must also be present.

These codes indicate localized enamel breakdown due to caries without visible dentin exposure (ICDAS 3) or a lesion that has progressed to involve the dentin (ICDAS 4, with a visible shadow).

Exclusion criteria: Large carious cavity, poor oral hygiene, presence of periodontal disease, presence of parafunctional habits and previous/failed restorations on the cavity.

The sample size was calculated using the Computer Program for Epidemiological Analysis (CPEA).[20] With formula as below

$$n = \frac{(Z\partial + Z\beta)2 \times 2 \times \sigma 2}{d^2}$$

where

$Z\partial$ represents the critical value from the standard normal distribution corresponding to a 95% confidence level (α = 0.05), which equals 1.96. Additionally, Z_β represents the critical value for a power of 80% (β = 0.2), with a corresponding value of 0.84. The population variance (σ^2) is assumed to be 1000. The desired detectable difference (d) is set at 25.01, based on the mean difference reported in a previous study.[21]

$$n = \frac{(1.96 + 0.84)^2 \times 2 \times 1000}{20.0^2}$$

n = 39.2 which is approximately 39, with 10% attrition rate it will be 42.9, approximately 43.

Since the restorations were in pairs, the sample size of 22 teeth per restoration resulted in the sample size of 44 teeth which received either restoration.

Prior to participation, volunteers received comprehensive instructions on the study's objectives and protocols, and provided written informed consent and authorization. Each participant underwent a randomized placement of the materials on contralateral sides of the mouth. A single, calibrated operator, who was not involved in the evaluation process, performed all restorative procedures. Following oral prophylaxis and shade matching, the teeth underwent surface cleansing with pumice slurry, and carious lesions were excavated to remove all active decay. Isolation of the working field was achieved using a combination of cotton rolls, saliva ejectors, and gingival retraction cords

All the participants received both Type II (Glass ionomer filling cement Type II i-dental, by Zahn fabrik H Rauter GmbH & co KG, Bad Sackingen, Germany) and Type IX (GC Fuji IX Gold label Glass ionomer posterior restoration) GIC on different sides of the mouth.

Two independent, calibrated examiners, who were blinded to the operator and treatment details, conducted separate evaluations of all restorations. The assessment was based on the modified USPHS criteria (16), a widely used evaluation tool in previous studies (7, 15). This criterion assesses five key parameters: retention, marginal integrity, marginal discoloration, anatomic form, and secondary caries, as outlined in Table 1.

Table 1: Modified USPHS criteria rating system.

Category	Rating scale		Criteria
	Acceptable	Unacceptable	
Retention	Alpha (A)	--	Restoration is present
	--	Charlie (C)	Restorations is partially or totally lost
Marginal integrity	Alpha (A)	--	No visible gap in which the explorer will penetrate
	Bravo (B)	--	There is visible gap, the explorer will penetrate or catch
	--	Charlie (C)	The explorer penetrates the gap and dentin or base is exposed
	--	Delta (D)	The restoration is mobile, partially or totally fractured or lost
Marginal discoloration	Alpha (A)	--	No discoloration
	Bravo (B)	--	Discoloration is present but has not penetrated along the margin
	--	Charlie (C)	Discoloration has penetrated along the margin
Anatomic form	Alpha (A)	--	Restoration is continuous with existing anatomic form
	Bravo (B)	--	Restoration is discontinuous with existing anatomic form, but dentin or base is not exposed
	--	Charlie (C)	Sufficient material is lost to expose dentin or base
Secondary caries	Alpha (A)	--	No caries is present at the margin of the restoration
	--	Charlie (C)	There is evidence of caries at the margin of the restoration

In cases where discrepancies arose during scoring, the examiners re-evaluated the restorations until a consensus was reached, which was then recorded as the final score. Restorations exhibiting caries, chipping, debonding, fracture, or severe discoloration were considered as definitive failures.

Evaluation was performed visually using an explorer following the modified USPHS.

At each evaluation visit, radiographs were taken to determine the presence of secondary caries while the marginal adaptation was evaluated visually using a metric 250 –*um* probe (Fissuren Sonde 250EX-

Deppeler, Rolle, Switerland). At the initial assessment, tooth shade was documented using a 3D master shade guide. Tooth sensitivity was evaluated through both tactile and air-blast stimulation. Additionally, the surface texture of the teeth was visually inspected using a mirror and explorer, and classified into one of three categories: enamel-like surface, surface rougher than enamel, and surface with unacceptable roughness.

Evaluation was done immediately after placement, finishing and polishing of the restoration (baseline), then subsequently at 1 month, 3 months and six months after placement of the restoration.

Data for the study was collected by means of an interviewer questionnaire. The data collected were biodata of the participants and evaluation assessments immediately after placement, finishing and polishing of the restoration (baseline), then subsequently at 1 month, 3 months and 6 months after placement of the restoration. To evaluate the consistency of assessments between examiners, inter-examiner agreement was calculated using the kappa statistic, which yielded a value of 0.78.

Data was screened for completeness and entered into a passworded personal computer. Analysis was done using Armonk, NY: IBM Corporation SPSS 26.0. The obtained data was subjected to descriptive statistics. The frequency and percentage for each assessment time point (baseline, 1 month, 3 months, and 6 months) for both GIC types within each participant was done. McNemar's test was used to compare the categorical outcomes between the two GIC types within each participant at each assessment time point (baseline, 1 month, 3 months, and 6 months); to determine if there were significant differences in the outcomes between the two GIC types within each participant.

The difference between the restorative materials at each period was analyzed by the Fisher's exact test or the Pearson's chi-square at 5% significance level.

RESULTS

The study participants consisted 16 individuals, with a median age of 25 years. The majority of participants (62.5%) were under the age of 30, while 37.5% were 30 years or older. In terms of gender, females made up 62.5% of the participants, while males comprised 37.5%. The educational background of the participants showed that 62.5% had a tertiary education, while 37.5% had a secondary education.

Regarding the matched tooth pairs, the results showed a high degree of accuracy. All 24 matched tooth pairs were correctly identified in terms of the side of the mouth. The arch was also correctly identified in 95.8% of cases, with only one incorrect match. However, the location of the teeth were correctly identified in only 66.7% of cases, with eight incorrectly matched (Table 2). In terms of restoration placement, as shown in Table 2, the mandibular arch received 77.1% of the restorations, while the maxillary arch received 22.9%. The second molars received the most restorations (43.8%), followed by the first molars (37.5%) with the least being the third molars (18.8%).

Table 2: **Baseline characteristics of study participants**

Characteristics	Frequency (n=16)	Percent
Age group (years)*		
<30	10	62.5
≥30	6	37.5
Sex		
Male	6	37.5
Female	10	62.5
Education Level		
Secondary	6	37.5
Tertiary	10	62.5
Matched tooth pairs	**(n = 24)**	
Side of mouth (Left/Right)		
Correct match	24	100.0
Incorrect match	0	0.0
Arch (Maxillary/Mandibular)		

Correct match	23	95.8
Incorrect match	1	4.2
Location of teeth (1st, 2nd , 3rd Molar)		
Correct match	16	66.7
Incorrect match	8	33.3

*Median (IQR) age: 25.0 (21.0 – 37.8) years

Table 3 shows the characteristics of the 48 intervention teeth, with 24 receiving Type IX interventions and 24 receiving Type II interventions. In terms of the left and right quadrants of the dental arch, the majority of Type IX interventions (21 out of 24, 87.5%) were performed on the right quadrant, while the majority of Type II interventions (21 out of 24, 87.5%) were performed on the left quadrant. The distribution of interventions by arch revealed that the majority of Type IX interventions (19 out of 24, 79.2%) were performed in the mandibular arch, while Type II interventions performed in the mandibular accounted for 75% (18 out of 24). The distribution of interventions by tooth type, showed that both Type IX and Type II interventions were commonly performed on second molars (21 out of 48, 43.8%), followed by first molars (18 out of 48, 37.5%) and third molars (9 out of 48, 18.8%).

Table 3: **Intervention distribution among the participants**

			Type IX									
				Side			**Arch**			**Tooth**		
			Left	Right	**Total**	Max	Mand	**Total**	1st Molar	2nd Molar	3rd Molar	**Total**
Type II	**Side**	Left	0	21	21							
		Right	3	0	3							
		Total	**3**	**21**	**24**							
	Arch	Max				5	1	6				
		Mand				0	18	18				
		Total				**5**	**19**	**24**				
	Tooth	1st Molar							6	3	0	9
		2nd Molar							2	7	2	11
		3rd Molar							1	0	3	4
		Total							**9**	**10**	**5**	**24**

Figure 1 shows the proportion of acceptable outcomes for Type IX and Type II GIC restorations across five clinical criteria: retention, marginal integrity, anatomic form, sensitivity, and surface texture. The remaining two criteria, marginal discoloration and secondary caries, demonstrated stable and favorable outcomes throughout the evaluation period. Assessments were conducted at four time points: baseline, 1 month, 3 months, and 6 months

For retention, Type IX GIC maintained a higher proportion of acceptable outcomes throughout the evaluation period, with a slight improvement at 6 months. In contrast, Type II GIC showed a significant decline in acceptable outcomes from baseline to 1 month, which remained low up to 6 months.

Regarding marginal integrity, Type IX consistently showed a higher proportion of acceptable outcomes throughout the evaluation period, despite a gradual decline over time. In contrast, Type II displayed fluctuations, with an initial decline followed by a sharp decrease at 6 months.

The anatomic form criterion showed that Type IX consistently demonstrated a higher proportion of acceptable outcomes over time, with a gradual improvement. In contrast, Type II displayed fluctuations, with an initial decline followed by a rise and subsequent decline.

For sensitivity, Type IX maintained a higher proportion of acceptable outcomes throughout the evaluation period, despite a gradual decline. Type II showed a consistently lower proportion of acceptable outcomes, with a decline at 6 months

The surface texture criterion showed that Type IX demonstrated a higher proportion of acceptable outcomes, with a gradual improvement peaking at 3 months. Type II, on the other hand, showed fluctuations, with an initial decline followed by an increase and stabilization.

Overall, the results indicate that Type IX consistently showed a higher proportion of acceptable outcomes across most criteria, outperforming Type II over time

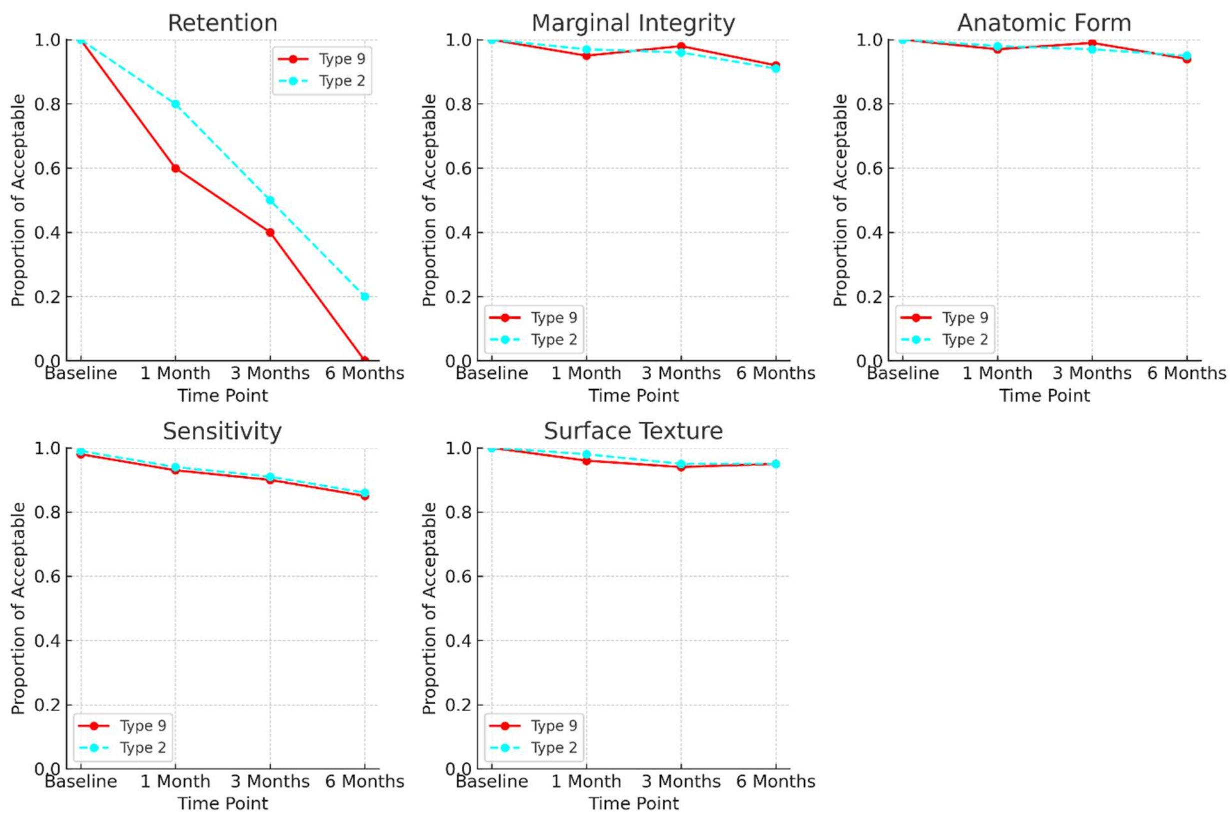

Figure. 1: Outcomes over time by Treatment arm

Table 4 shows the Clinical Outcomes of Type II and Type IX GIC restorations. The clinical outcomes of Type II and Type IX treatments were evaluated at baseline (0 months), 1 month, 3 months, and 6 months. The outcomes assessed included retention, marginal integrity, marginal discoloration, anatomic

form, secondary caries, sensitivity, and surface texture. Marginal discoloration and secondary caries showed no change across the evaluation periods.
Retention Outcomes: At baseline, all 24 teeth treated with Type IX and Type II GIC had acceptable retention. At 1 month, 1 tooth treated with Type II had unacceptable retention. At 3 months, 1 tooth treated with Type IX had unacceptable retention. At 6 months, 1 tooth treated with Type IX and 1 tooth treated with Type II had unacceptable retention and this was not significant (P=0.999)
Marginal Integrity Outcomes: At baseline, all 24 teeth treated with Type IX and Type II GIC had acceptable marginal integrity. At one month, 1 tooth treated with Type II had unacceptable marginal integrity. At 3 months, all 24 teeth treated with Type IX and Type II GIC had acceptable marginal integrity. At six months, 2 teeth treated with Type II had unacceptable marginal integrity, while 1 tooth treated with Type IX had unacceptable marginal integrity.
Anatomic Form Outcomes: At baseline, all 24 teeth treated with Type IX and Type II GIC had acceptable anatomic form. At one month, 1 tooth treated with Type II had an unacceptable anatomic form. At three months, all 24 teeth treated with Type IX and Type II GIC had acceptable anatomic form. At six months, 2 teeth treated with Type II had unacceptable anatomic form, but this was not statistically significant (P=0.999)
Sensitivity Outcomes: At baseline, all 24 teeth treated with Type IX and Type II GIC had acceptable sensitivity. At one month, 1 tooth treated with Type II had unacceptable sensitivity. At three months, 2 teeth treated with Type II and 1 tooth treated with Type IX had unacceptable sensitivity. At six months, 3 teeth treated with Type II and 1 tooth treated with Type IX had unacceptable sensitivity, however this was not statistically significant (P=0.999)
The results showed no significant difference in retention, marginal integrity, marginal discoloration, anatomic form, secondary caries, surface texture and sensitivity outcomes between the two treatment groups.
Overall, the results suggest that both Type II and Type IX treatments had high success rates for retention, marginal integrity, anatomic form, and sensitivity, with no significant difference between the two groups

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Table 4: McNemar comparison of the restorations

Type II	Time (months)	Retention	Type IX Unacceptable n (%)	Acceptable n (%)	Total (%)	p-value*
	0	Unacceptable	0 (0.0)	0 (0.0)	0 (0.0)	Na
		Acceptable	0 (0.0)	24 (100.0)	24 (100.0)	
	1	Unacceptable	0 (0.0)	1 (4.2)	1 (4.2)	Na
		Acceptable	0 (0.0)	23 (95.8)	23 (95.8)	
	3	Unacceptable	1 (4.2)	0 (0.0)	1 (4.2)	0.999
		Acceptable	0 (0.0)	23 (95.8)	23 (95.8)	
	6	Unacceptable	0 (0.0)	1 (4.3)	1 (4.2)	0.999
		Acceptable	1 (100.0)	22 (95.7)	23 (95.8)	
		Marginal integrity				
	0	Unacceptable	0 (0.0)	0 (0.0)	0 (0.0)	Na
		Acceptable	0 (0.0)	24 (100.0)	24 (100.0)	
	1	Unacceptable	0 (0.0)	1 (4.2)	1 (4.2)	Na
		Acceptable	0 (0.0)	23 (95.8)	23 (95.8)	
	3	Unacceptable	0 (0.0)	0 (0.0)	0 (0.0)	Na
		Acceptable	0 (0.0)	24 (100.0)	24 (100.0)	
	6	Unacceptable	0 (0.0)	2 (8.7)	2 (8.3)	0.999
		Acceptable	1 (100.0)	21 (91.3)	22 (91.7)	
		Anatomic form				

0	Unacceptable	0 (0.0)	0 (0.0)	0 (0.0)	Na
	Acceptable	0 (0.0)	24 (100.0)	24 (100.0)	
1	Unacceptable	0 (0.0)	1 (4.2)	1 (4.2)	Na
	Acceptable	0 (0.0)	23 (95.8)	23 (95.8)	
3	Unacceptable	0 (0.0)	0 (0.0)	0 (0.0)	Na
	Acceptable	0 (0.0)	24 (100.0)	24 (100.0)	
6	Unacceptable	0 (0.0)	2 (8.7)	2 (8.3)	0.999
	Acceptable	1 (100.0)	21 (91.3)	22 (91.7)	
	Sensitivity				
0	Unacceptable	0 (0.0)	0 (0.0)	0 (0.0)	Na
	Acceptable	0 (0.0)	24 (100.0)	24 (100.0)	
1	Unacceptable	0 (0.0)	1 (4.2)	1 (4.2)	Na
	Acceptable	0 (0.0)	23 (95.8)	23 (95.8)	
3	Unacceptable	2 (100.0)	1 (4,5)	3 (12.5)	0.999
	Acceptable	0 (0.0)	21 (95.5)	21 (87.5)	
6	Unacceptable	3 (60.0)	1 (5.3)	4 (16.7)	0.999
	Acceptable	2 (40.0)	18 (94.7)	20 (83.3)	

**McNemar Test, NA: Not Applicable*

DISCUSSION

Glass ionomer cements (GICs) offer several advantages, including rapid placement, cost-effectiveness, biocompatibility, and fluoride release.[22] Additionally, GICs exhibit a unique property among dental materials: chemical adhesion to tooth structure.[22] This study investigated the clinical performance of two types of GIC restorations, Type II and Type IX, over a six-month period. The evaluation focused on key clinical parameters, including retention, marginal integrity, marginal discoloration, anatomic form, secondary caries, surface texture and sensitivity.

The median age of the participants in this study was 25 years, which is consistent with the age range reported for individuals with restored molars.[23] In terms of demographics, the study found a higher proportion of female participants, which aligns with the findings of a previous study in adults[24] and one in children.[25] However, this differs from another study on adults,[23] which reported a different demographic profile. Another study observed that Type II glass ionomer cement and Type IX glass ionomer cement was used more in males as compared to females.[26]

The randomization process effectively matched the side of the mouth for intervention pairs. To ensure standardized clinical conditions, oral environment, dietary habits, and oral hygiene practices, a split-mouth technique was utilized in this study. This approach enabled the simultaneous evaluation of the investigated materials under identical conditions. A similar methodology was also employed in a previous study,[25] allowing for a comparable assessment of the materials' performance. As a result, the majority of Type IX interventions were performed on the right side, while Type II interventions were primarily performed on the left side. In terms of arch distribution, both Type IX and Type II interventions were predominantly performed in the mandibular arch. This suggests that the mandibular arch may be more susceptible to caries or restorative needs, or that clinicians may have a preference for restoring teeth in this arch. The mandibular arch received a higher proportion of restorations, which is consistent with previous findings.[23,24] This suggests that the distribution of restorative materials in the mouth may be influenced by factors such as patient age, arch type, and tooth location, as supported by existing literature.[27]

As expected, all the teeth restored in this study were molars, given that molars are the most commonly affected teeth by caries.[28,29] Specifically, second molars were the most frequently restored, followed by first molars, while third molars received the fewest restorations. Interestingly, this finding diverges from previous reports, which found that first molars were more commonly restored than second molars, with third molars being the least restored.[23,27] The discrepancy between these studies may be attributed to differences in patient demographics, oral health habits, or dietary factors. Another possible explanation for the higher restoration rate of second molars is their anatomy. Due to their position and morphology, second molars may be more prone to caries or restorative needs. However, it is essential to note that the study's design did not control for arch and tooth type, which limits the interpretation of results, related to restoration placement and intervention characteristics.

The evaluation of the two treatment types was based on seven clinical criteria. While distinct patterns emerged across five of these criteria, namely retention, marginal integrity, anatomic form, sensitivity, and surface texture, no changes were observed in marginal discoloration and secondary caries throughout the evaluation period. This stability in marginal discoloration and secondary caries is consistent with previous research evaluating Type II and Type IX glass ionomer cements (GICs), which also reported no changes in these criteria over time.[25,30]

One of the most notable findings is the difference in retention outcomes between the two treatment types. Type IX maintained a higher proportion of acceptable outcomes throughout the evaluation period, with a gradual decrease peaking at 3 months before a slight improvement at 6 months. In contrast, Type II showed a consistently lower proportion of acceptable outcomes, with a sharp decline from baseline to 1 month. This suggests that Type IX may have better retention properties over time. These findings align with previous research suggesting that both high-viscosity (Type IX) and conventional (Type II) GICs exhibit comparable retention rates in primary and permanent dentition.[22]

The marginal integrity outcomes also differed between the two treatment types. Type IX consistently demonstrated a higher proportion of acceptable marginal integrity, with a gradual improvement over time. In contrast, Type II showed fluctuations, with a decline at 3 months followed by a sharp decrease at 6 months, indicating potentially weaker marginal sealing properties. This finding partially aligns with a previous study on primary teeth, which reported no significant difference in marginal adaptation scores between Type II and Type IX at 3 and noted a significant increase in marginal adaptation deterioration for both materials over time, particularly at 6 months.[25]

The anatomic form criterion revealed that Type IX consistently demonstrated a higher proportion of acceptable outcomes, with a gradual improvement over time. In contrast, Type II showed fluctuations, with an initial decline followed by an increase and subsequent decline, indicating potentially weaker anatomic stability. In contrast, a previous study on primary teeth[25] found significant differences in anatomic form scores between Type II and Type IX at 3 and 6 months. Notably, Type II showed better anatomic form scores than Type IX at these time points. The discrepancy between this study's findings and the previous study's results may be attributed to the fact that the previous study used light-cured Type II GIC.

The sensitivity outcomes revealed that Type IX consistently maintained a higher proportion of acceptable outcomes compared to Type II at all time points, indicating a potential benefit in reducing sensitivity. Although both types showed a decline in acceptable outcomes over time, Type IX demonstrated a more favorable sensitivity profile.

The surface texture criterion showed that Type IX consistently demonstrated a higher proportion of acceptable outcomes, with a gradual improvement peaking at 3 months. Type II, on the other hand, exhibited fluctuations, with an initial decline followed by an increase and stabilization. These findings suggest that both treatment types have varying levels of success in maintaining surface texture over time. Although, these results highlight differences in surface texture, previous studies have reported high clinical success rates for both materials, with no significant differences between them.[26] The primary reasons for failure in these studies were material fractures, retention loss, and poor marginal adaptation or anatomical form.[26] Additionally, insufficient material application was identified as a contributing factor to failure in another study.[22]

Despite the differences observed in the study, both Type II and Type IX glass ionomer cements (GICs) demonstrated excellent performance in terms of retention, marginal integrity, marginal discoloration, anatomic form, secondary caries, surface texture and sensitivity over the study period. Their high success rates can be attributed to their inherent properties, such as bonding to tooth structure, releasing fluoride, and providing a seal against bacterial leakage.

However, the relatively small sample size limits the statistical power of the findings. Although trends in favor of Type IX GIC were observed in several clinical parameters, these differences did not reach statistical significance. Therefore, caution must be exercised in interpreting the results, and future studies with larger sample sizes and longer follow-up periods are recommended to confirm these preliminary findings.

The lack of significant differences between the two groups across all criteria suggests that both Type II and Type IX GICs are reliable choices for clinical restorative procedures. This finding supports the use of both materials in clinical practice, providing clinicians with confidence in their ability to achieve successful restorative outcomes.

CONCLUSION

Both Type IX and Type II Glass Ionomer Cements demonstrate excellent clinical performance and durability in dental restorations, with no statistically significant differences between the two materials in this study. However, given the limited sample size, further research with larger participant groups and extended observation periods is needed to validate these results and better assess the long-term clinical efficacy of these restorative materials.

LIMITATIONS

The study had several limitations that should be considered when interpreting the results. One major limitation was the short follow-up period of 6 months, which may not have been sufficient to capture the long-term performance and durability of the glass ionomer cement restorations. Another limitation was the narrow scope of clinical criteria evaluated, which included only retention, marginal integrity, anatomic form, sensitivity, and surface texture. This limited assessment may not have provided a comprehensive understanding of the restorations' overall performance. Furthermore, the study lacked a control group, which would have allowed for a comparison of the glass ionomer cement restorations with other types of restoration materials. This omission limits the ability to draw conclusions about the relative performance of the glass ionomer cement restorations.

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Conflict of Interest

None declared

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