Clinical Performance of Short Fibre-reinforced Glass Ionomer Cement Restorations in Cervical Carious Lesions: 12-Month Randomized Clinical Trial

Keywords

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ABSTRACT

The aim was to assess the clinical performance of experimental short fiber-reinforced glass-ionomer cement (FR-GIC) in the treatment of cervical caries lesions. A total of 45 patients were randomly enrolled in this trial according to the split-mouth design. The FR-GIC was prepared by adding short glass fibers at a mass ratio of 20% into the powder portion of Fuji II LC. The cervical lesions in the intervention group were restored with FR-GIC, while unmodified Fuji II LC was applied as the control. Clinical evaluation was performed by two blinded operators at baseline, at 6, and 12 months using modified USPHS criteria. The data were analyzed using Friedman's test, followed by the Nemenyi post hoc test with a significance level of $\alpha = 0.05$. After 1 year, all restorations were fully retained. There was no statistically significant difference ($p>0.05$) between the two materials based on the evaluated criteria. Both groups had 4 (10%) cases with Bravo scores for cavos-surface marginal discoloration. Regarding marginal integrity, Bravo scores were observed in 5 (12.5%) cases in the intervention group and 4 (10%) cases in the control group. Both materials in the treatment of cervical caries lesions demonstrated satisfactory clinical outcome throughout the 12-month follow-up.

INTRODUCTION

The market for direct restorative materials has seen a noticeable growth and development in the last several years. The concepts of biomimetics, minimally invasive techniques, and bioactivity are primarily responsible for these developments. The most common direct restorative materials are resin composite and glass ionomer cement (GIC), both with unique characteristics.[1] Resin composites are widely acknowledged as the most aesthetically pleasing material, boasting satisfactory physical properties. When combined with dentin bonding agents, resin composites have been shown in previous clinical trials to be effective in the restoration of class V lesions.[2] However, they come with drawbacks, including high cost, technique sensitivity, the need for adhesive bonding, and the potential for allergies.[1] Recently, alkasite-based restorative material has been investigated as a potential restorative option for cervical lesions, showing enhanced

performance.[3] Nonetheless, more clinical trials are need to confirm the findings. On the other hand, GICs match the requirements of biomimetics, minimally invasive procedures, and bioactivity.

Conventional GICs possess many distinct characteristics that make them useful in many clinical applications. The advantages of these products encompass the features of fluoride ion hydrodynamics, biocompatibility, advantageous thermal expansion and contraction, as well as chemical bonds to the tooth structure.[4] Owing to these properties, GICs are the primary and highly recommended materials for restoring cervical lesions.[5] Nevertheless, despite possessing these notable benefits, GICs exhibit inferior surface texture, a high level of porosity, and inferior mechanical characteristics such as fracture toughness, brittleness, and surface wear when compared to contemporary resin composites.[6-8]

Resin-modified glass ionomer cements (RMGICs) were invented to merge the mechanical characteristics of resin composites with the ion releasing capabilities found in conventional GICs.[9,10] These materials have the same composition as conventional GICs, with the incorporation of poly (acrylic acid), but the difference in RMGIC is the addition of a polymerizable resin monomer, commonly 2-hydroxyethyl methacrylate (HEMA).[9] Nevertheless, despite this compositional advancements, two essential mechanical characteristics of RMGICs fracture toughness and flexural property were not substantially improved. These properties have a significant impact on the material's clinical performance, especially in areas subjected to high levels of occlusal stresses.[8,11]

The reinforcement of RMGIC restorative materials is crucial, and numerous researchers have concentrated on enhancing the mechanical capabilities by including different types of fillers into the GIC powder component. The fillers employed were hydroxyapatite powders, bioactive glass particles, nanoclay, and short glass fibers.[12,13] The application of short glass fibers as a reinforcement technology produced encouraging results, with superior toughening and flexural performance observed compared to conventional RMGIC.[13,14]

The development of short fiber-reinforced RMGIC (FR-GIC) is aimed at improving fracture toughness and loading capacity without compromising the potential for ion release.[13–15] This enhancement in mechanical characteristics is expected to address concerns that might otherwise impact the long-term clinical performance of this material. However, there is currently no clinical evidence to support this suggestion, raising the question of whether it is safe to use the material without any coverage. The oral environment often presents a synergistic combination of microbiological, mechanical, chemical, and temperature problems. Hence, it is evident that the impacts of these problems would significantly impact the behavior of a material and consequently affect the effectiveness and durability of restoration through longer periods of clinical use. As a result, the goal of the present clinical trial was to investigate the clinical efficacy and biocompatibility of experimental FR-GIC in the treatment of cervical caries lesions. The tested null hypothesis was that FR-GIC in Class V restorations would perform similarly to unmodified RMGIC restorations in terms of clinical outcomes.

MATERIAL AND METHOD

TRIAL DESIGN AND SETTINGS

This trial is a triple-blind (operator, assessors and patients) split mouth randomized clinical trial with two parallel groups and equal allocation ratio. The trial protocol was registered on clinical trials.gov with ID: NCT06185881 and was conducted in conservative dentistry clinic of Faculty of Dentistry, Cairo university, Egypt from March 2022 to December 2023. The trial reporting's follow the Consolidated Standards of Reporting Trials (CONSORT) statements.

ETHICAL APPROVAL

The trial was conducted in accordance with the ethical principles outlined in the World Medical Association Declaration of Helsinki. The research protocol underwent revision and received permission from the research ethics committee of the Faculty of Dentistry, with the assigned approval number 25-12-21. All of the participants were informed of the aim and all procedures of this trial and accepted to participate by signing the informed consent.

ELIGIBILITY CRITERIA

Eligible patients were those with age from 18 to 38 years old, good oral hygiene and had at least two cervical carious vital permanent teeth. The restored teeth should be in favourable occlusion and good periodontal conditions. Medical compromised, allergic or pregnant patients were excluded from the trial also patients with previous restoration, any sign or symptom of irreversible pulpitis, necrosis, or any pulp pathosis.

CALCULATION OF SAMPLE SIZE

The sample size was calculated based on a previous study by vural *et al.*, in which the retention rate of resin modified glass ionomer after one year was 98%.[16] By implementing a two tailed Z test for difference between two independent proportions with an alpha level of 5% and a power of 80%. The minimum sample size needed was 41 per group in order to detect a difference of 20%. This was increased by 10% to compensate for possible dropouts to be 45 per group. Sample size was performed using G*Power version 3.1.9.2 for windows.

RANDOMIZATION AND ALLOCATION CONCEALMENT

Simple randomization process was done by a contributor that was not further involved in any phase of the trial. The operator selected random numbers that were placed in opaque sealed envelope (https://www.random.org/) and opened the list at the time of application of the glass ionomer only.

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BLINDING

The operator was blinded as the two intervention and control group capsules have the same mixing capsule shape and a contributor was selecting each one to apply based on the randomization list as well as the patients and the two outcome assessors were blinded to the type of the restoration used.

PRODUCTION OF EXPERIMENTAL FR-GIC MATERIAL

For this study, we utilized a radiopaque light-cured encapsulated RMGIC (Fuji II LC, GC, Tokyo, Japan). Each capsule of this material included 0.33 g of powder and 0.1 g (0.085 mL) of liquid. The FR-GIC material was made by precisely opening the capsule and replacing 20% of its powder weight with short glass fibers (Central Glass Fiber Co., Ltd., Tokyo, Japan). These fibers had a diameter of 6 μm and an average length of 140 μm. Before being combined with the liquid component, the glass fibers were completely blended with the GIC powder (20 wt.%).[14,15] The control group did not have any fiber inclusion.

CAVITY PREPARATION AND RESTORATION

An experienced operator injected the local anaesthesia (Artinibsa 4% 1:100.000, Inibsa Dental, Spain) to the patient at the selected site. Multiple isolation of teeth was performed using a rubber dam (Sanctuary® powder free latex dental dam, Perak, Malaysia). Cervical cavities were prepared using high speed carbide burs (330 dental carbide bur, Komet, South Carolina, USA) with air/water coolant handpiece then soft caries was removed (selective caries removal) using excavator (51/52 double ended excavator, Dentsply Maillefer, Ballaigues, Switzerland) until firm dentin at pulpal (axial wall) is reached. All of the cavity preparation procedures were done following the recent clinical consensus of caries excavation.[17]

For restoring the cavities in both groups; the operator cleaned the cavity by water, dried by cotton blotting then applied the cavity conditioner (Dentin Conditioner, GC, Tokyo, Japan) for 10 sec, rinsed and gently dried the cavity preparation using gentle air blasts. The selected glass ionomer capsule was mixed for 10 seconds, placed into the capsule applier and then dispensed into the prepared cavities in increments up to 2 mm and light cured for 20 seconds using LED light curing device (LED.F, Woodpecker, China) with intensity (>700 mW/cm²). Then, the restoration was finished using fine grit diamond stones (Microdont, São Paulo, Brazil) and polished using rubber points and bristle brushes conjugated with ultrafine diamond paste (Microdont). Polishing was performed at low speed (30.000 rpm) under copious water cooling. Glass ionomer coat (GC Fuji COAT LC, GC, Tokyo, Japan) was applied on the restoration using a microbrush then light cured for 10 seconds following the manufacturer's instructions.

The materials used in this study and their specification are listed in Table 1.

CLINICAL EVALUATION

Two blinded outcome assessors evaluated the restorations using modified USPHS criteria Table 2 at baseline, six months and one year. The assessors were trained about the criteria before starting the trial and calibrated to a Kappa value of 90% at least for inter and intra-examiner agreement per each criteria. When there was any conflict in scores, it was resolved by discussion.

STATISTICAL ANALYSIS

The numerical data were reported in terms of the mean and standard deviation values. The data, which was categorized and ordered, was displayed as frequency and percentage values. The ordinal data were examined using Friedman's test,

Table 1. Material descriptions and specifications.

Product	Specifications	Composition
Fuji II LC (GC, Tokyo, Japan)	Resin modified glass ionomer (RMGIC)	Liquid: 2-Hydroxyethylmethacrylate 30-35 wt.%,, Polyacrylic acid 30-35 wt.%, and water 20-30 wt.%. Powder: Fluoro-aluminumsilicate 99 wt.%, pigment < 1 wt.%
Experimental modified Fuji II LC	Short fiber-reinforced glass ionomer (FR-GIC)	Liquid: 2-Hydroxyethylmethacrylate, Polyacrylic acid and water. Powder: Fluoro-aluminumsilicate (80 wt.%), micrometer scale glass fiber filler (20 wt.%)
Dentin Conditioner (GC, Tokyo, Japan)	Mild polyacrylic conditioner	Distilled water 77 wt.%, polyacrylic acid 20 wt.%, aluminum chloride hydrate 3 wt.%
Fuji Coat LC (GC, Tokyo, Japan)	Light-cured glass ionomer coating	Multifunctional methacrylate 25-50 wt.%, methyl methacrylate 25-50 wt.% photoinitiator 1-5 wt.% Stabilizer < 1 wt.%

Table 2. Modified USPHS criteria.

Criterion	Score	Description	Measuring method
Post-operative Hypersensitivity	Alpha	Absent	Patient interviewing
	Charlie	Present	
Secondary caries	Alpha	No caries present along the margins	Visual inspection with mirror
	Charlie	There is visual evidence of dark carious discolouration along the restoration	
Gross fracture	Alpha	Restoration is intact and fully retained	Visual inspection with mirror
	Bravo	Some portion of the restoration is still intact and can be repaired	
	Charlie	Restoration is completely fractured.	
Color match	Alpha	The restoration matches the shade and translucency of the adjacent tooth.	Visual inspection with mirror
	Bravo	There is a mismatch in the shade and translucency but it is within the normal range of tooth shade.	
	Charlie	The mismatch is beyond the normal range of the tooth shades and translucency.	
Cavosurface marginal discoloration	Alpha	There is no visual evidence of any marginal discoloration at the junction of the restoration and the adjacent tooth structure	Visual inspection with mirror
	Bravo	There is visual evidence of shallow marginal discoloration.	
	Charlie	There is visual evidence of deep marginal discoloration toward a pulpal direction.	
Marginal integrity	Alpha	The explorer does not catch and there is no visible crevice along the margin of the restoration.	Visual inspection with mirror and explorer
	Bravo	The explorer catches and there is visible evidence of a crevice but the dentin or the base are not exposed.	
	Charlie	There is crevice defect extended to the dentin	
Surface Texture	Alpha	the surface is smooth like the adjacent enamel	Visual inspection with mirror and explorer
	Bravo	Slightly rough or pitted but can be refinished	
	Charlie	Very rough, cannot be refinished	
Anatomic form (wear)	Alpha	Restoration continuous with existing anatomic form	Visual inspection with mirror and explorer
	Bravo	Restoration is slightly lost and discontinuous with existing anatomic form but clinically accepted	
	Charlie	Restoration is discontinuous and clinically failed	

followed by the Nemenyi *post hoc* test. The threshold for statistical significance was established at a p-value of less than 0.05 for all tests. The statistical study was conducted using R statistical analysis software version 4.3.2 for Windows (R Core Team, 2024). R is a programming language and software environment used for statistical computing. The R Foundation for Statistical Computing is located in Vienna, Austria. The URL for the R programming language is https://www.R-project.org/.

RESULTS

This split-mouth study was conducted on (45) cases (i.e., (19) males and (26) females) with the mean age of (35.29±6.40) years. Forty participants only completed the follow up of the trial, two cases dropped out of the study after 6 months, three more dropped after 12 months (*Figure 1*).

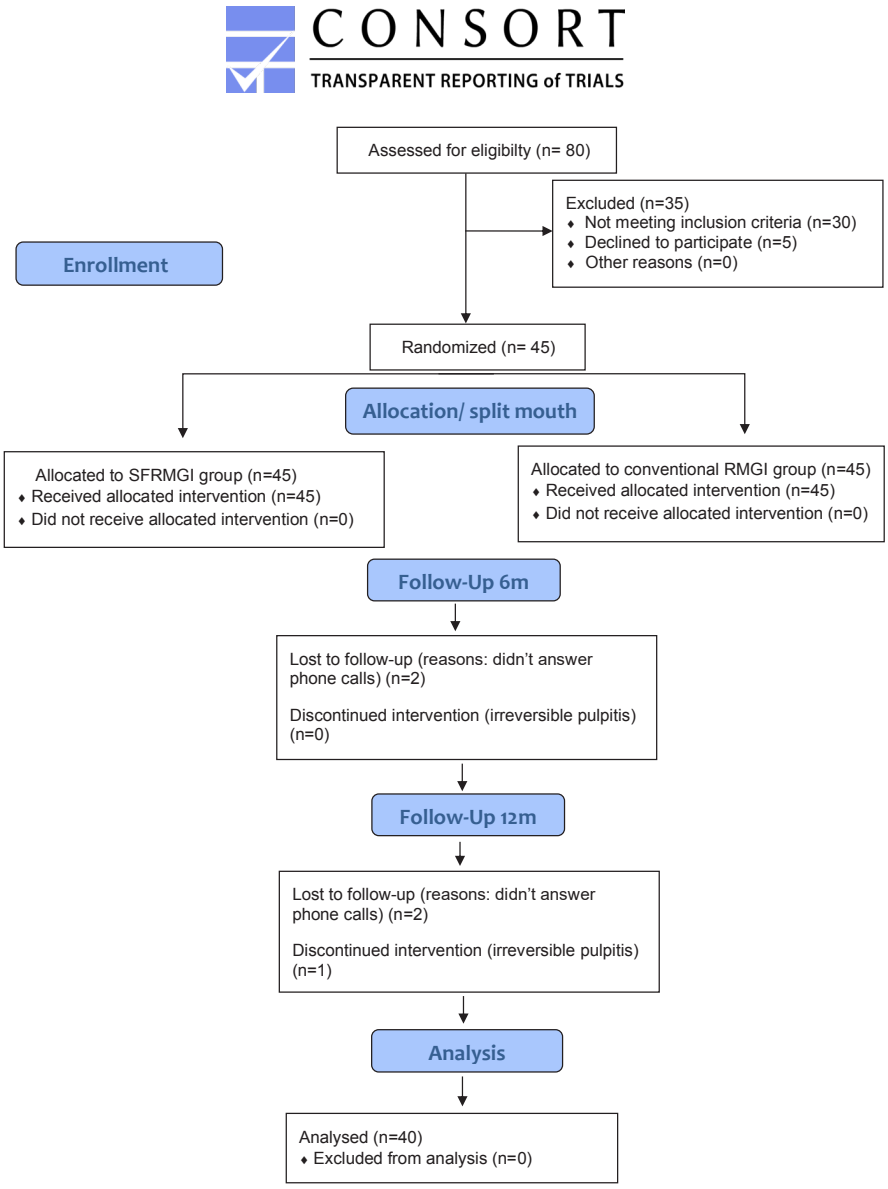

Figure 1: Flowchart of the study.

There was no statistically significant difference ($p>0.05$) between the two materials based on the evaluated criteria. Results of inter and intragroup comparisons for clinical scores are presented in Table 3 and in Figure 2. All cases of both groups at baseline had an alpha score. After 12 months, the retention rate for both groups was 100%.

For postoperative hypersensitivity 2 cases in the intervention group and 3 in the control had a Charlie score after 7 days and until 6 months. After 6 and 12 months, in the intervention group, Bravo score was measured in a single case for gross fracture and in 3 cases for color match. For cavos-surface marginal discoloration, after 6 months, 3 cases in the in the intervention group and two cases in the control group had a Bravo score. While after 12 months, 4 cases in both groups had the score. For marginal integrity, Bravo score was found after 6 months in 2 cases in the intervention group and in 3 cases in the control group. However, after 12 months it was found in 5 cases in the intervention and in 4 cases in the control. For other parameters and intervals, all cases had an alpha score *(Figure 3)*.

For cavo-surface marginal discoloration measured in the intervention group and for marginal integrity measured in both groups, there was a significant increase in the percentage of cases with Bravo score during follow-up intervals ($p<0.05$). However, for other intervals, the difference was not statistically significant ($p>0.05$).

It is noteworthy to emphasize that neither the control group nor the intervention group exhibited any signs of gingival irritation or inflammation surrounding the restorations.

DISCUSSION

The split-mouth design was selected to ensure that both restorative materials would be subjected to a nearly equal oral environment. The main criterion for inclusion was the presence of at least two cervical carious lesions requiring restorative therapy. As a result, the patients included in the study generally had a high level of caries activity. It is possible that this might impact the rates of success. Nevertheless, after a span of one year, all restorations were effectively retained.

Table 3. Inter and intragroup comparisons of different clinical parameters.

Parameter	Time	Score	n (%)		Test statistic	p-value
			Intervention	Control		
Post-operative hypersensitivity	Baseline	Alpha	45 (100.00%)	45 (100.00%)	NA	NA
		Charlie	0 (0.00%)	0 (0.00%)		
	7 days	Alpha	43 (95.56%)	42 (93.33%)	0.00	1
		Charlie	2 (4.44%)	3 (6.67%)		
	6 months	Alpha	41 (95.35%)	40 (93.02%)	0.00	1
		Charlie	2 (4.65%)	3 (6.98%)		
Test statistic			4.00	6.00		
p-value			0.135	0.053		
Secondary caries	Baseline	Alpha	45 (100.00%)	45 (100.00%)	NA	NA
		Charlie	0 (0.00%)	0 (0.00%)		
	6 months	Alpha	43 (100.00%)	43 (100.00%)	NA	NA
		Charlie	0 (0.00%)	0 (0.00%)		
	12 months	Alpha	40 (100.00%)	40 (100.00%)	NA	NA
		Charlie	0 (0.00%)	0 (0.00%)		
Test statistic			NA	NA		
p-value			NA	NA		
Anatomic contour (wear)	Baseline	Alpha	45 (100.00%)	45 (100.00%)	NA	NA
		Bravo	0 (0.00%)	0 (0.00%)		
		Charlie	0 (0.00%)	0 (0.00%)		
	6 months	Alpha	43 (100.00%)	43 (100.00%)	NA	NA
		Bravo	0 (0.00%)	0 (0.00%)		
		Charlie	0 (0.00%)	0 (0.00%)		
	12 months	Alpha	40 (100.00%)	40 (100.00%)	NA	NA
		Bravo	0 (0.00%)	0 (0.00%)		
		Charlie	0 (0.00%)	0 (0.00%)		
Test statistic			NA	NA		
p-value			NA	NA		
Surface texture	Baseline	Alpha	45 (100.00%)	45 (100.00%)	NA	NA
		Bravo	0 (0.00%)	0 (0.00%)		
		Charlie	0 (0.00%)	0 (0.00%)		
	6 months	Alpha	43 (100.00%)	43 (100.00%)	NA	NA
		Bravo	0 (0.00%)	0 (0.00%)		
		Charlie	0 (0.00%)	0 (0.00%)		
	12 months	Alpha	40 (100.00%)	40 (100.00%)	NA	NA
		Bravo	0 (0.00%)	0 (0.00%)		
		Charlie	0 (0.00%)	0 (0.00%)		
Test statistic			NA	NA		
p-value			NA	NA		

Table 3 continued.....

Table 3. Inter and intragroup comparisons of different clinical parameters continued....

Gross fracture	Baseline	Alpha	45 (100.00%)	45 (100.00%)	NA	NA
		Bravo	0 (0.00%)	0 (0.00%)		
		Charlie	0 (0.00%)	0 (0.00%)		
	6 months	Alpha	42 (97.67%)	43 (100.00%)	0.00	1
		Bravo	1 (2.33%)	0 (0.00%)		
		Charlie	0 (0.00%)	0 (0.00%)		
	12 months	Alpha	39 (97.50%)	40 (100.00%)	0.00	1
		Bravo	1 (2.50%)	0 (0.00%)		
		Charlie	0 (0.00%)	0 (0.00%)		
Test statistic			2.00	NA		
p-value			0.386	NA		
Color match	Baseline	Alpha	45 (100.00%)	45 (100.00%)	NA	NA
		Bravo	0 (0.00%)	0 (0.00%)		
		Charlie	0 (0.00%)	0 (0.00%)		
	6 months	Alpha	40 (93.02%)	43 (100.00%)	6.00	0.149
		Bravo	3 (6.98%)	0 (0.00%)		
		Charlie	0 (0.00%)	0 (0.00%)		
	12 months	Alpha	37 (92.50%)	40 (100.00%)	6.00	0.149
		Bravo	3 (7.50%)	0 (0.00%)		
		Charlie	0 (0.00%)	0 (0.00%)		
Test statistic			6.00	NA		
p-value			0.053	NA		
Cavo-surface marginal discoloration	Baseline	Alpha	45 (100.00%)[B]	45 (100.00%)	NA	NA
		Bravo	0 (0.00%)	0 (0.00%)		
		Charlie	0 (0.00%)	0 (0.00%)		
	6 months	Alpha	40 (93.02%)[A]	41 (95.35%)	0.00	1
		Bravo	3 (6.98%)	2 (4.65%)		
		Charlie	0 (0.00%)	0 (0.00%)		
	12 months	Alpha	36 (90.00%)[A]	36 (90.00%)	0.00	1
		Bravo	4 (10.00%)	4 (10.00%)		
		Charlie	0 (0.00%)	0 (0.00%)		
Test statistic			6.50	6.00		
p-value			0.039*	0.053		
Marginal integrity	Baseline	Alpha	45 (100.00%)[B]	45 (100.00%)B	NA	NA
		Bravo	0 (0.00%)	0 (0.00%)		
		Charlie	0 (0.00%)	0 (0.00%)		
	6 months	Alpha	41 (95.35%)[A]	40 (93.02%)A	0.00	1
		Bravo	2 (4.65%)	3 (6.98%)		
		Charlie	0 (0.00%)	0 (0.00%)		
	12 months	Alpha	35 (87.50%)[A]	36 (90.00%)A	0.00	1
		Bravo	5 (12.50%)	4 (10.00%)		
		Charlie	0 (0.00%)	0 (0.00%)		
Test statistic			7.60	6.50		
p-value			0.022*	0.039*		

NA: Not Applicable, Values with different superscript letters within the same vertical column and clinical parameter are significantly different *significant (p<0.05)

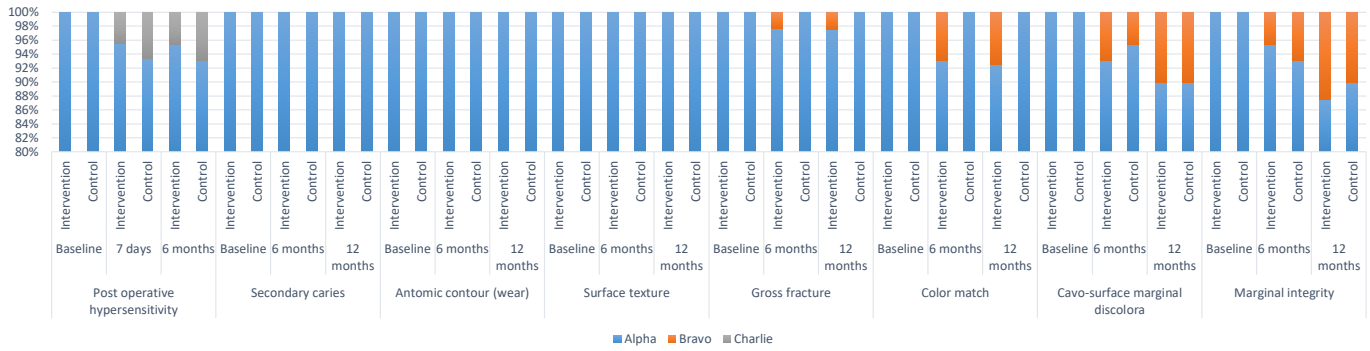

Figure 2: Stacked bar chart showing clinical scores.

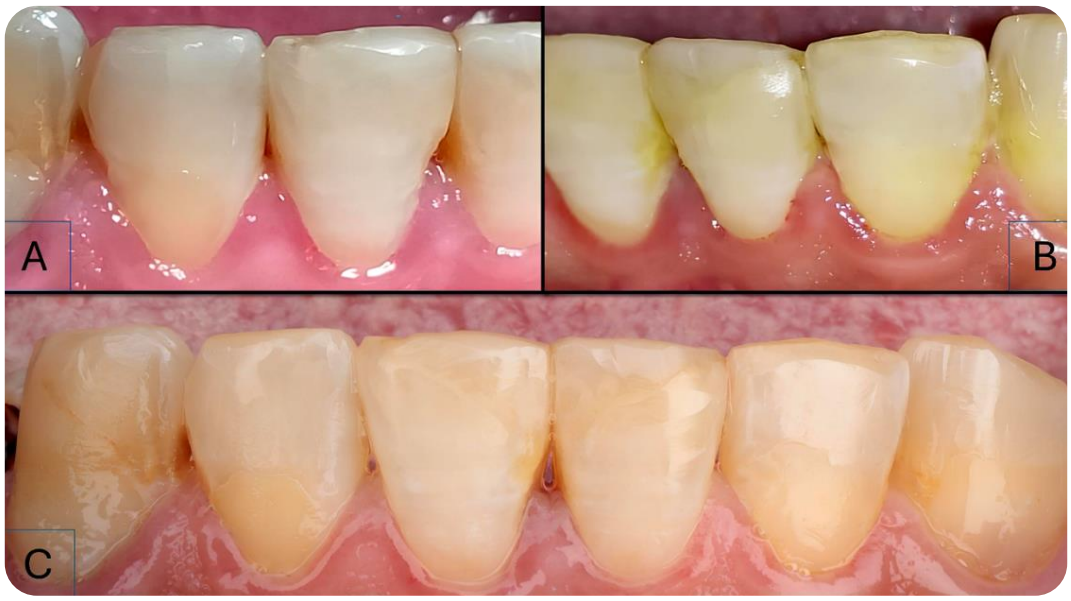

Figure 3: Representative photo showing A) LR2 intervention FR-GIC restoration at 6 months B) LL2 control restoration at 6 months while C) both restorations after 1 year.

The tested null hypothesis was accepted because there was no difference in retention and other modified USPHS clinical criteria between the experimental (FR-GIC) and unmodified Fuji II LC materials in the current clinical trial.

In Class V cavities, RMGICs are the preferred restorative material due to the absence of macromechanical retention and the high C-factor.[18] They exhibit high retention rates and are user-friendly.[16,18] The loss of retention serves as the most evident sign of restoration failure and is considered the most reliable diagnostic criterion, showing minimal signs of bias. In contrast, outcome variables like surface texture and marginal adaptation can be influenced by different examiners' measurements.

RMGICs do not necessitate the use of phosphoric acid etching or adhesive application on dentin or enamel. Alternatively, it is advisable to use a solution of polyacrylic acid to effectively eliminate the majority of the smear layer and expose hydroxyapatite for the purpose of establishing chemical (ionic) bonding with dentin and enamel surfaces.[19,20] Due to the mild surface demineralization, RMGICs that utilize a polyacrylic acid conditioner create an extremely thin hybrid layer.[19] Cardoso and his colleagues demonstrated that the bond strength between dentin and RMGICs is enhanced when dentin prepared with a bur is treated with the corresponding polyacrylic acid solution before the application of RMGICs.[21] When the dentin surface is free of smear layer, the bond strengths remain consistent regardless of whether a 20% polyacrylic acid solution is used before applying the RMGIC.[21] This indicates that treating the smear layer is necessary to expose the calcium bonding sites on the dentin surface.

Fuji II LC was chosen as the RMGIC material due to its inclusion of the monomer 2-hydroxyethyl methacrylate (HEMA), which facilitates both hydrogen and covalent bonding. These bonds are essential for creating a durable adhesion between the fibres and the cement matrix.[14] This link plays a crucial role in the transmission of stress and improve the toughness.[22] Accordingly, the use of FR-GIC demonstrates superior *in vitro* outcomes compared to unmodified RMGIC.[13-15] The reinforcement was achieved by including discontinuous glass microfibers, ranging from 200 to 500 µm in length, into RMGIC powder (with a weight percentage of 20%). The mixture was fully blended using a high-speed centrifugal mixing unit to provide a uniform composition. According to the literature, a weight loading of

20% short glass fibers is optimal for achieving the intended mechanical enhancement while preserving the capacity to release fluoride and calcium.[14,15] Additionally, it was found that proper material mixing becomes impractical with a higher percentage of fiber mass.[23] Lohbauer *et al*., demonstrated the presence of a distinct reactive layer (with a thickness ranging from 2 to 20 µm) at the interface between the GIC matrix and glass fiber that is produced during the process of hardening.[24] Garoushi *et al*., demonstrated that the microfibers in this experimental FR-GIC were effectively wetted with the matrix.[14] This likely accounts for the positive reinforcement effect and the improved resistance to crack propagation. Furthermore, Ivica *et al*., demonstrated that the fluoride and calcium release capacity from this FR-GIC after a 30-day period is comparable to unmodified Fuji II LC.[15] Remarkably, the wear characteristics of FR-GIC were found to be similar to those of Fuji II LC, with none of these materials displaying a significantly rough or worn surface following the test.[14]

Numerous laboratory studies have been conducted to assess the characteristics of this fiber-reinforced glass ionomer; however, their results may not consistently replicate real clinical behavior. Hence, conducting clinical studies remains the most reliable method for predicting its actual performance when exposed to the oral environment. In this clinical study, no statistically significant differences were observed between the two materials in terms of the assessed criteria. However, a total of three cases (3%) with a Bravo score were recorded for color match in FR-GIC restorations after 6 and 12 months. This implies that FR-GIC may exhibit slightly higher water absorption compared to unmodified Fuji II LC. The color matching of RMGICs has been suboptimal in numerous clinical studies. A study documented a Bravo rating of 52% for one RMGIC after 18 months of clinical use.[25] Another study observed an unsatisfactory color match for two RMGICs in a combination of noncarious and carious cervical lesions after three years.[26] Furthermore, our findings align with the study conducted by Perdigao *et al*., which reported a 100% Alpha score in the color match of Fuji II LC after a one-year in clinical service.[20]

A single case of chipping fracture was noted in the FR-GIC restoration after 6 months. The observed chipping failure in the intervention group could possibly be attributed to inclusion of air bubbles, especially considering that this material is not yet fully optimized.

Throughout the trial, none of the restorations showed any visible evidence of soft tissue irritation or plaque accumulation. This aligns with the findings of Lassila *et al*., who demonstrated a comparable amount of *Streptococcus mutans* adhesion to the short fiber-reinforced material, as seen in their study on *Streptococcus mutans* adhesion.[27] Additionally, Attik *et al*., conducted a study revealing that short fiber composite (having same glass fiber as in FR-GIC) had a less harmful impact on the survival of primary gingival cells compared to other examined bulk-fill composites.[28]

Postoperative sensitivity is a commonly reported issue in clinics following the restoration of cervical lesions. Within a specific time frame, sensitivity was detected in a total of 5 restorations from the two investigated materials. However, no instances of postoperative sensitivity were observed in any of the restorations throughout the 12-month monitoring period. This phenomenon can be attributed to the bioactivity or capacity of materials to release ions. Studies have indicated that glass ionomer materials, in particular, have biological advantages due to the release of ions such as fluoride, sodium, phosphate, and silicate.[29,30]

The limitation of this study was the small sample size, as the investigation adopted a split-mouth study design with strict inclusion and exclusion criteria, so restricting the number of eligible patients. The location of caries lesions can also be seen as a limitation, as few lesions are found at cemento-enamel junction, affecting both the enamel and the dentin, while others are solely on the crown.

Additionally, the one-year duration of the study is relatively short for evaluating the prolonged clinical performance of restorative materials. However, this short-term investigation provides insights into the initial bonding capability and biocompatibility of this experimental material. Future investigations have been planned to include medium- and long-term clinical evaluations of this fiber-reinforced FR-GIC material in different applications particularly in load-bearing areas.

CONCLUSION

Both materials tested in this study exhibited similar performance at the one-year recall. The application of short fiber-reinforced RMGIC, without surface coverage in Class V restorations, yielded satisfactory clinical outcomes as assessed by the modified USPHS criteria, with no major biocompatibility problems.

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