Journal of Neonatal Surgery
ISSN(Online): 2226-0439
Vol. 14, Issue 19s (2025)
https://www.jneonatalsurg.com

OPEN ACCESS

Clinical Evaluation of Glass Ionomer Cement Restorations

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Cite this paper as: Dr. Safeena Munir, Dr Amna Sadat Cheema, BDS, Faizan Ahmad Khan, Dr. Hafiz Muhammad Adil, Dr Ghida Haider Naqvi, Dr.Kainat Hayat, (2025) Clinical Evaluation of Glass Ionomer Cement Restorations. *Journal of Neonatal Surgery*, 14 (19s), 946-953.

ABSTRACT

Background: Dental restorative materials have changed over the last decades with the ultimate goals in mind; the esthetic requirements of the restored teeth and the role of the restoration in preventing secondary caries.

Objective: To evaluate the effectiveness of conventional and resin-modified GICs in clinical application, emphasizing adhesion and cariogenic potential.

Methodology: This cross-sectional study was conducted over one year. January 2023 to January 2024. The sample size calculated was 150. The patients who came within our research inclusion criteria were explained the study aim and method, and potential inconveniences collected data were entered and analyzed using SPSS version 24.0. The analysis involved both descriptive and inferential statistical methods.

Results: Resin-modified GIC demonstrated significantly higher adhesion success compared to conventional GIC (p = 0.00001), while adhesion failure was more frequent with conventional GIC. Secondary caries were significantly less prevalent with resin-modified GIC than with conventional GIC (p = 0.003). Age was significantly associated with secondary caries (p < 0.00001), with the highest prevalence in the 51–65 age group, but not with adhesion success (p = 0.783). Gender significantly influenced adhesion outcomes (p = 0.003), with females showing higher success rates than males. Females had a higher prevalence of secondary caries than males (p = 0.083).

Conclusion: The use of resin-modified GIC has a higher percentage of adhesion success and better caries control than conventional GIC. Based on the improved durability and wear resistance of the restored material, resin-modified GIC would be preferred for cases where caries activity could be considered ‘‘higher,’’ or where maintaining an optimal moisture content would be difficult. Such findings support the consideration of materials in restoring teeth in the best way possible with the aim of satisfying patients

Keywords: *Glass Ionomer Cement (GIC), Resin-Modified GIC, Dental Restorations, Adhesion, Secondary Caries*

1. INTRODUCTION

Dental restorative materials have changed over the last decades with the ultimate goals in mind; the esthetic requirements of the restored teeth and the role of the restoration in preventing secondary caries. (Reza Rezaie et al., 2020). Among these, glass ionomer cements (GIC) are preferable for their chemical properties as well as clinical applications because of their property to bond to dental hard tissues and also for the property of their ability to release fluoride – which has an anti-caries

effect. (Amin et al., 2021). These materials have been used in restorative dentistry since the 1970s in most caries-susceptible populations or in cases where it is preferable to minimize the extent of tooth preparations. (Kotsanos & Wong, 2022).

GICs are classified into two primary types: predominantly with normal glass ionomer cement and resin-modified glass ionomer cement. (Ge, Quock, Chu, & Yu, 2023). Generally accepted GICs involve a chemical interaction between fluoro aluminosilicate glass powder and polyacrylic acid to set and provide a controlled and slow release of fluoride which has a favorable effect against recurrent caries. (Hill, 2022; Saher, 2019). This fluoride-releasing capacity may be invaluable in pediatric and geriatric dentistry cases where patients may have higher caries threat or difficulties in practicing good dental hygiene.(Kawai, de Souza, & Feine, 2024) However, although conventional GICs are valued for their ease of use, biocompatibility, and fluoride release,(Mustafa, Soares, Paris, Elhennawy, & Zaslansky, 2020) They also have drawbacks in physical properties concerning wear resistance, strength, and moisture sensitivity when setting restrictions on their application in highly stressed occlusal regions. (Aby, 2020).

To overcome these limitations, a new material called Resin-modified glass ionomer cement (RMGICs) was developed. RMGICs replace a portion of the hydrophobic resin with a stronger hydrophilic resin component within the matrix of the GICs (Dionysopoulos, Gerasimidou, & Papadopoulos, 2022). This alteration enhances the wear resistance, bond strength, and setting time early enough than the normal material used for fabrication, making it ideal for stress-bearing restorations. (Vichitgomen, 2020). In addition, RMGICs indicated increased adhesion on tooth structure due to the presence of the resin component that may enhance the durability of the restoration. (Alzebiani, 2023). However, it is still possible to express doubts about the material containing the resin, including the fluoride release and caries inhibition compared to conventional GIC. (Albelasy, Hamama, Chew, Montaser, & Mahmoud, 2022).

The clinical success of restorative materials relies heavily on two critical factors: bonding and anti-caries properties. (Zhou et al., 2019). Cohesion reduces microleakage which in turn reduces secondary caries and increases the durability of restorations. (Satish, 2020). Hence, GICs are perceived to be beneficial based on the chemical bond between the material and enamel and dentin; however, the comparison between the adhesive properties of the conventional and resin-modified types has been the subject of continuing clinical research. (Dziuk et al., 2021). RMGICs are thought to be more adhesive due to mechanical interlocking with the resin, yet conventional GICs may be more caries-protective because of fluoride release. (Borges, Torres, & Schlueter, 2020; Khalil & Al-Shamma, 2024). It is important to be aware of these differences, and applying them enables practitioners to select the appropriate dental material that best suits the individual patient for a particular cavity, caries risk, location, and occlusal force, among other factors.

Releasing fluoride and caries inhibition are special features that GICs have contrary to other restorative materials, such as composites. (Pires et al., 2020). Ordinary and polyacid-modified GICs can also have a cariostatic effect since they release fluoride ions which may help in the process of sound tooth structure remineralization and decrease bacterial activity. (Basheer, 2020; Jaiswal, 2020). Conventional GICs release fluoride at a slow and sustained rate, but the resin-modified GICs release fluoride at a quicker rate in the initial hours and may reduce over time. (Dziuk et al., 2021). Hence, understanding the effects of these differences in the sustained release of fluoride relevant to caries control is necessary for creating practice guidelines for GICs.

This study will offer a strong foundation for the evaluation of the advantages and drawbacks of recommending each kind of GIC, and help in identification of the suitable materials depending on the clinical applications. Therefore, this evaluation aims to improve restorative efficiency overall, and for particular patients who may require both adhesive and anti-cariogenic properties of GIC restorations. The purpose of this study is to evaluate the effectiveness of conventional and resin-modified GICs in clinical applications with an emphasis on adhesion and cariogenic potential.

2. METHODOLOGY

This cross-sectional clinical study was implemented in one year that began from January 2023 to January 2024. The main aim was to evaluate and compare the clinical effectiveness of conventional and resin-modified GIC whereby adherence and cariostatic properties were of interest. This investigation was carried out in the Dental Department of Lahore Medical and Dental College which usually employs both types of GIC restorations in restorative dentistry.

The sample size was calculated with OpenEpi software since it is the software used for epidemiological calculations. Assuming a confidence level of 95%, a power of 80%, and an anticipated prevalence of successful adhesion and caries inhibition at 50% (to allow for maximum variability), the calculated sample size was 150 participants. (https://www.openepi.com). The sampling technique used for this study was non-probability consecutive sampling. Through this approach, the study guaranteed that all patients as per the inclusion criteria who attend the dental department for restorative treatment and meet the inclusion criteria during the study period will be included in the sample till the desired sample size is obtained.

To reduce variability and generalization of results, specific criteria for subject selection were set. Inclusion criteria were patients aged 18 to 65 years who needed restorations with C-GIC or RMGIC, good general health, and no severe systemic disease that can affect the health of teeth or dental restorations, restorations positioned in non-stress bearing regions only (that is, cervical or proximal restorations) and patients who signed informed consent for entry into the trial. Exclusion criteria included patients with any hypersensitivity to any of the materials used in its composition; pit and fissure caries in the adjacent tooth; high-stress areas restored, such as the occlusal surface of the premolar or molars; and extensive cavities that require additional reinforcement beyond GIC such as class II cavities involving cuspal coverage.

The data collection process was very structured to avoid any variability in the clinical evaluation of the participants and to provide a snapshot of each participant's status at a given time. Based on the study criteria, patients attending the Dental Department of Lahore Medical and Dental College for restorative procedures were selected. Those patients who came within our research inclusion criterion were explained about the study aim and method, and potential inconveniences. The participants were also asked to freely contribute to the study, their written informed consent was taken. To each qualifying patient, a clinical examination was done to evaluate the functionality of the present GIC resto-rations among them. This assessment involved evaluation of restorations that were recalled (either conventional or resin-modified GIC restorations) based on clinical records and treatment history.

In terms of marginal integrity and adhesion, the restoration was checked visually and tactually with a dental probe for any space, evidence of debonding, or microleakage. For each restoration, the examiner determined the existence of secondary caries localized at the restoration margins. This was done visually and by palpation based on diagnostic parameters for secondary caries. For each patient, structured data were collected by filling out the data collection form. These were the age and gender of the patient, conventional or resin-modified GIC used, and the clinical observations on adhesion and cariogenicity respectively. A form was used in the collection of all data thus giving a measure of standardization throughout the study.

Marginal integrity and microleakage were investigated to assess adhesion. This was done by simple observation and palpation using a dental probe to determine whether a gap was present between the restoration and the tooth structure. The presence of secondary caries was examined based on the area around the restoration for caries and concerned those patients who returned for follow-up at 6 and 12 months to detect changes in the progress of carious lesions around the restorations. A structured proforma was used to gather data which included demographic details, the type of GIC used, and clinical findings.

Statistical Analysis

The collected data were entered and analyzed using SPSS version 24.0. The analysis involved both descriptive and inferential statistical methods. Frequencies and percentages were calculated for categorical variables, such as type of GIC, age groups, and gender distribution. Continuous variables (e.g., age) were summarized as means and standard deviations. Chi-square tests were used to compare the presence of secondary caries and adhesion success rates between conventional and resin-modified GIC groups. A p-value of less than 0.05 was considered statistically significant.

3. RESULTS

A total of 150 participants were included in the study, with an even gender distribution of 50.0% male (n = 75) and 50.0% female (n = 75) with M: F of 1:1. (Figure I) The participants' ages ranged from 18 to 65 years, with the largest proportion falling in the 31-50 age group (43.3%), followed by 18-30 years (30.0%) and 51-65 years (26.7%) with the mean age of 40 ±12.3 years. (Figure II) Regarding the type of glass ionomer cement (GIC) used, 53.3% of participants received conventional GIC restorations, while 46.7% received resin-modified GIC. (Figure III)

The clinical evaluation of glass ionomer cement (GIC) restorations revealed significant differences between conventional and resin-modified GIC regarding adhesion success and secondary caries presence. Adhesion success was observed in 56.5% of the resin-modified GIC group, notably higher than the 43.4% adhesion success rate in the conventional GIC group ($p = 0.00001$). Conversely, adhesion failure was more common in the traditional GIC group, with 85.7% experiencing failure compared to only 14.2% in the resin-modified GIC group. Additionally, secondary caries was present in 70.0% of participants with conventional GIC restorations, significantly higher than the 30.0% observed in the resin-modified GIC group ($p = 0.003$). Secondary caries was absent in 55.0% of the resin-modified GIC group compared to 45.0% in the conventional GIC group. (Table I)

The clinical performance comparison between conventional and resin-modified glass ionomer cement (GIC) restorations indicated significant differences in adhesion and caries prevention. In terms of adhesion, the resin-modified GIC demonstrated a higher success rate, with 56.5% of cases showing successful adhesion, compared to 43.4% in the conventional GIC group ($p = 0.00001$). Adhesion failure was notably higher in the traditional GIC group, where 85.7% experienced failure, versus only 14.2% in the resin-modified GIC group. Regarding secondary caries, 70.0% of participants with conventional GIC restorations had secondary caries present, significantly higher than the 30.0% observed in the resin-modified GIC group ($p = 0.003$). Absence of secondary caries was reported in 55.0% of the resin-modified GIC group, in contrast to 45.0% in the

conventional GIC group. These findings underscore the superior clinical outcomes associated with resin-modified GIC in terms of both adhesion success and caries inhibition. (Table I)

The relationship of age with the clinical outcomes of conventional and resin-modified glass ionomer cement (GIC) restorations showed no significant association with adhesion success ($p = 0.783$). Among the different age groups, adhesion success rates were 30.4% for participants aged 18-30 years, 43.4% for those aged 31-50 years, and 26.0% for those aged 51-65 years. However, age was significantly associated with the presence of secondary caries ($p < 0.00001$). Secondary caries was most prevalent in the 51-65 years age group (50.0%), followed by the 18-30 years group (30.0%) and the 31-50 years group (20.0%). (Table II)

The relationship of gender with clinical outcomes indicated a statistically significant association with adhesion ($p = 0.003$). Adhesion success was higher among female participants (56.5%) compared to male participants (43.4%). Adhesion failure was more frequent in males (71.4%) than in females (28.5%). While gender was not significantly associated with the presence of secondary caries ($p = 0.083$), secondary caries were more prevalent among females (60.0%) compared to males (40.0%). (Table III)

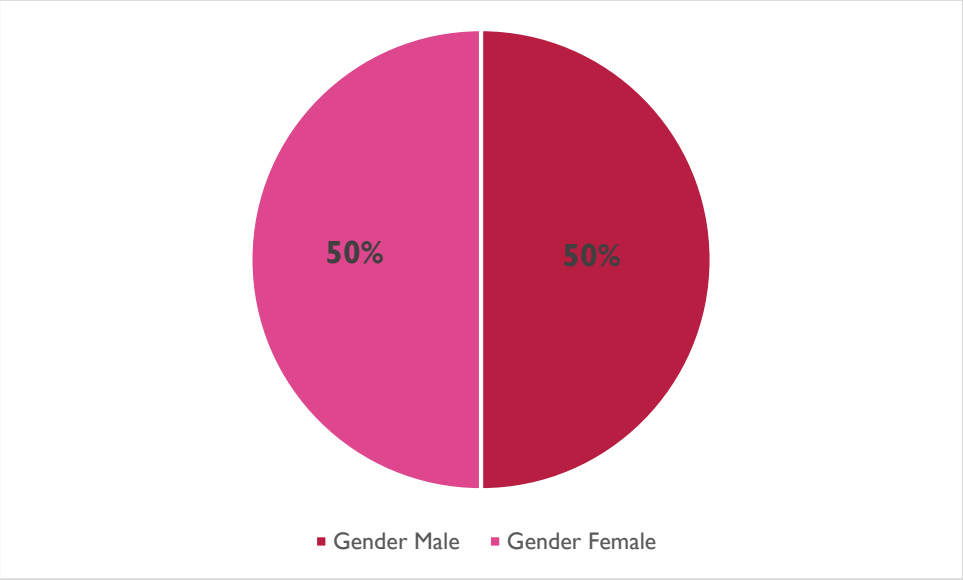

Figure I: Gender Distribution of the Study Participants

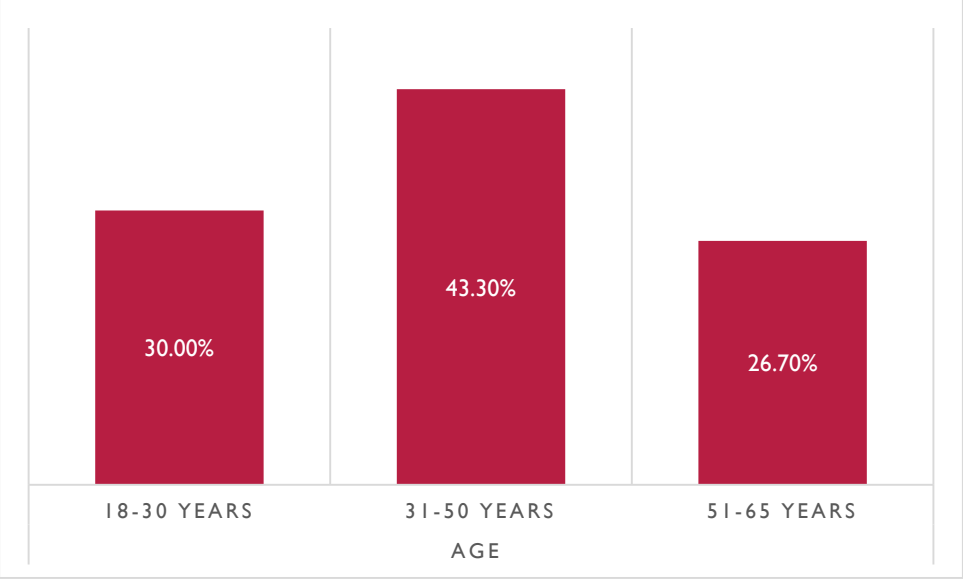

Figure II: Frequency of Age Groups of the Study Participants

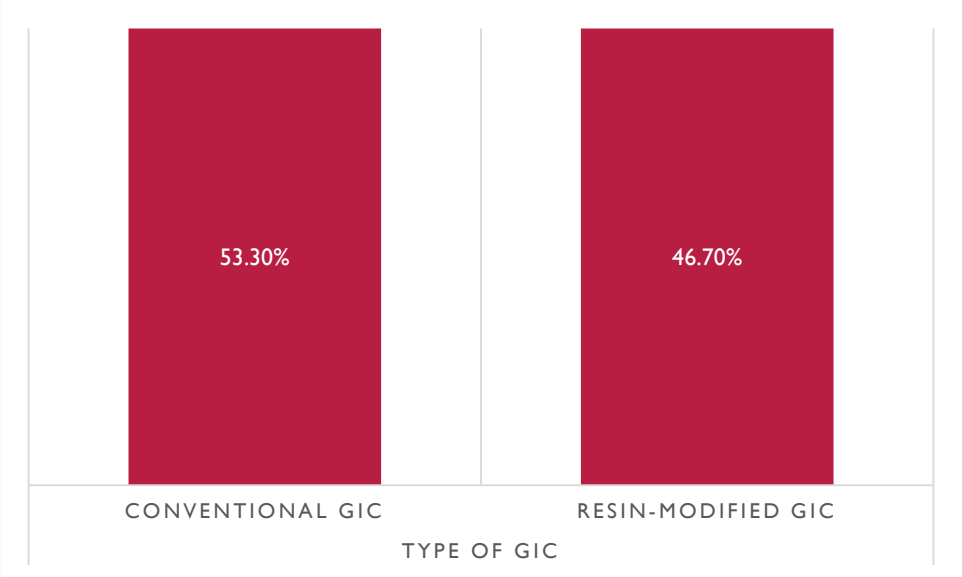

Figure III: Frequency of Conventional GIC and Resin-Modified GIC

Table I: Clinical Performance of Conventional vs. Resin-Modified GIC Concerning Adhesion and Secondary Caries

Clinical Outcome	**Conventional GIC (n=80)**	**Resin-Modified GIC (n=70)**	**p-value**
Adhesion			0.00001
Successful	50 (43.4%)	65 (56.5%)	
Failed	30 (85.7%)	5 (14.2%)	
Secondary Caries			0.003
Present	35 (70.0%)	15 (30.0%)	
Absent	45 (45.0%)	55 (55.0%)	

Table II: Relationship of Age with Clinical Outcomes of Conventional and Resin-Modified GIC Restoration

Clinical Outcome	**Age**			**p-value**
	18-30 years (n=45)	**31-50 years (n=65)**	**51-65 years (n=40)**	
Adhesion				0.783
Successful	35 (30.4%)	50 (43.4%)	30 (26.0%)	
Failed	10 (28.5%)	15 (42.8%)	10 (28.5%)	
Secondary Caries				<0.00001
Present	15 (30.0%)	10 (20%)	25 (50%%)	
Absent	30 (30.0%)	55 (55.0%)	15 (15.0%)	

Table III: Relationship of Gender with Clinical Outcomes of Conventional and Resin-Modified GIC Restoration

Clinical Outcome	Gender		p-value
	Male (n=75)	Female (n=75)	
Adhesion			0.003
Successful	50 (43.4%)	65 (56.5%)	
Failed	25 (71.4%)	10 (28.5%)	
Secondary Caries			0.083
Present	20 (40.0%)	30 (60.0%)	
Absent	55 (55.0%)	45 (45.0%)	

4. DISCUSSION

The present study compared conventional GIC restorative material with a resin-modified GIC restorative material based on clinical performance criteria related to adhesion success and secondary caries of patients treated at Lahore Medical and Dental College. Analysis of the outcomes indicated higher adhesion success in the use of resin-modified GIC with a 56.5% success rate as opposed to a 43.4% success rate for conventional GIC. Furthermore, the percentage of patients with secondary caries was considerably lower with resin-modified GIC, 30.0% compared to conventional GIC, 70.0%. These findings offer considerable support to the use of resin-modified GIC in clinical practice because of the potential to decrease caries and improve adhesion.

Reviewing literature about conventional and resin-modified GICs, several contrasting results can be observed regarding adhesion and caries based on the present research. In the present study, higher adhesion rates were reported with resin-modified GIC probably because of the higher hydrophilicity of the material that enhances bonding in dental restorations. Our findings are by Koç-Vural U et al. (2024), who found that RMGICs showed far superior levels of adhesion and stability, especially in moist conditions as compared to the conventional GICs (Koç-Vural, Kerimova-Köse, & Kiremitci, 2024). A study by Sreejith SL et al., 2024 also found high levels of adhesion and stability. (Sreejith & Saraswathy, 2024). However, other research conducted on the two forms of GICs, by Dziuk Y et al (2021), showed that there was no significant difference between the two forms. (Dziuk et al., 2021). These differences indicate that technical variation could influence adhesion effects and the need for consistent practices.

Resin-modified GIC also demonstrated the inhibition of caries, which is consistent with some studies indicating that resin-modified GIC possesses better caries preventive properties. A systemic review conducted by Ge KX et al. (2022) showed that patients who benefited from resin-modified GIC restorations observed a reduction in the recurrence of secondary caries as compared to the conventional GIC restoratives. This reduction is attributed to the fact that the resin-modified GIC has better-incremented fluoride release compared to the conventional GIC and thus provides better caries protection in the long term (Ge, Quock, Chu, & Yu, 2022). Another study by Lekha et al., (2020) corroborated the works done on the caries inhibition properties of resin-modified GIC which the author stated that due to its modified composition, the material released fluoride in small quantities for extended periods, thus preventing secondary caries (Lekha, 2020). Another research study conducted by Albelasy EH et al., (2022) also showed no occurrence of secondary caries in resin-modified GIC restorations (Albelasy et al., 2022).

The present study supports the fact that the clinical application of resin-modified GIC particularly in situations where better bond strength and resistance to caries is desirable. The physical properties of Resin-modified GIC such as enhanced fluoride release and enhanced bonding capacity make the material appealing for minimizing secondary caries and ensuring the durability of the restoration in the oral cavity. These results argue for the material choice adding to the current conclusion on RMGIC handing that the material could be considered in clinical situations where moisture control is a problem or where the caries risk is high. It is recommended that subsequent clinical study designs extend on the clinical success and cephalometric evaluation of RMGIC and address the impact of individual patient parameters on the success of the restorative procedure.

5. CONCLUSION

In the present work, a comparison has been made between the clinical properties of conventional GIC and resin-modified GIC in restoring dental material with a new concept revealing that the use of resin-modified GIC has a higher percentage of adhesion success and better caries control than of conventional GIC. Based on the observed profiles of the effects, specifically, the improved durability and wear resistance of the restored material, resin-modified GIC would be preferred for cases where caries activity could be considered ‘‘higher,’’ or where maintaining an optimal moisture content would be difficult. Such findings support the consideration of materials in restoring teeth in the best way possible with the aim of satisfying patients.

Author Contributions:

Acknowledgments:

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest concerning the research, authorship, and/or publication of this article.

Funding

Self-funded

REFERENCES

[1] Aby, H. (2020). A Clinical Evaluation of Bulk Fill GIC Versus Bulk Fill Composite in Primary Molars: A Split Mouth Randomized Clinical Trial. Rajiv Gandhi University of Health Sciences (India),

[2] Albelasy, E. H., Hamama, H. H., Chew, H. P., Montaser, M., & Mahmoud, S. H. (2022). Secondary caries and marginal adaptation of ion-releasing versus resin composite restorations: a systematic review and meta-analysis of randomized clinical trials. Scientific Reports, 12(1), 19244.

[3] Alzebiani, N. (2023). The ability of Experimental Resin Modified Glass Ionomer Cements (RMGICs) to Remineralise and Form Apatite on Immersion. Queen Mary University of London,

[4] Amin, F., Rahman, S., Khurshid, Z., Zafar, M. S., Sefat, F., & Kumar, N. (2021). Effect of nanostructures on the properties of glass ionomer dental restoratives/cements: a comprehensive narrative review. Materials, 14(21), 6260.

[5] Basheer, H. (2020). Comparative Evaluation of Compressive Strength, Microleakage, Fluoride Release and Recharge Ability of Various Glass Ionomer Based Restorative Materials: An in Vitro Study. Rajiv Gandhi University of Health Sciences (India),

[6] Borges, A. B., Torres, C. R. G., & Schlueter, N. (2020). Preventive Measures and Minimally Invasive Restorative Procedures. Modern Operative Dentistry: Principles for Clinical Practice, 631-666.

[7] Dionysopoulos, D., Gerasimidou, O., & Papadopoulos, C. (2022). Modifications of glass ionomer cement using nanotechnology: recent advances. Recent Progress in Materials, 4(2), 1-22.

[8] Dziuk, Y., Chhatwani, S., Möhlhenrich, S. C., Tulka, S., Naumova, E. A., & Danesh, G. (2021). Fluoride release from two types of fluoride-containing orthodontic adhesives: Conventional versus resin-modified glass ionomer cement—An in vitro study. PLoS One, 16(2), e0247716.

[9] Ge, K. X., Quock, R., Chu, C.-H., & Yu, O. Y. (2022). The preventive effect of glass ionomer restorations on new caries formation: A systematic review and meta-analysis. Journal of Dentistry, 125, 104272.

[10] Ge, K. X., Quock, R., Chu, C.-H., & Yu, O. Y. (2023). The preventive effect of glass ionomer cement restorations on secondary caries formation: A systematic review and meta-analysis. Dental Materials.

[11] Hill, R. (2022). Glass ionomer polyalkenoate cement and related materials: past, present and future. British Dental Journal, 232(9), 653-657.

[12] Jaiswal, M. (2020). Comparative Evaluation of the Demineralization Inhibition Potential of Bioactive Composite Restorations in Primary Teeth: An in Vitro Study. Rajiv Gandhi University of Health Sciences (India),

[13] Kawai, Y., de Souza, R., & Fine, J. (2024). Randomized Controlled Trials in Restorative Dentistry and Prosthodontics. In Randomized Controlled Trials in Evidence-Based Dentistry (pp. 199-224): Springer.

[14] Khalil, R. J., & Al-Shamma, A. M. (2024). Micro-shear bond strength of a novel resin-modified glass ionomer luting cement (eRMGIC) functionalized with organophosphorus monomer to different dental substrates. Heliyon,

10(9).

[15] Koç-Vural, U., Kerimova-Köse, L., & Kiremitci, A. (2024). Long-term clinical comparison of a resin-based composite and resin-modified glass ionomer in the treatment of cervical caries lesions. Odontology, 1-12.

[16] Kotsanos, N., & Wong, F. (2022). Restoration of Carious Hard Dental Tissues. In Pediatric Dentistry (pp. 281-314): Springer.

[17] Lekha, K. C. (2020). Comparative Evaluation of Compressive Strength, Diametral Tensile Strength, Microhardness, Microleakage, Fluoride Release and Recharge of Resin Modified Gic (Fuji Ii Lc), Bioactive Restorative (Activa Kids) and Alkasite Restorative (Cention N): An in Vitro Study. Rajiv Gandhi University of Health Sciences (India),

[18] Mustafa, H. A., Soares, A. P., Paris, S., Elhennawy, K., & Zaslansky, P. (2020). The forgotten merits of GIC restorations: A systematic review. Clinical Oral Investigations, 24, 2189-2201.

[19] Pires, P. M., Neves, A. d. A., Makeeva, I. M., Schwendicke, F., Faus-Matoses, V., Yoshihara, K., . . . Sauro, S. (2020). Contemporary restorative ion-releasing materials: Current status, interfacial properties, and operative approaches. British Dental Journal, 229(7), 450-458.

[20] Reza Rezaie, H., Beigi Rizi, H., Rezaei Khamseh, M. M., Öchsner, A., Reza Rezaie, H., Beigi Rizi, H., . . . Öchsner, A. (2020). Dental restorative materials. A Review on Dental Materials, 47-171.

[21] Saher, T. (2019). Bioactive Glass–A New Horizon of Composite: Fluoride Release and Uptake in Comparison with GIC, Resin Modified GIC–An in Vitro Study. Rajiv Gandhi University of Health Sciences (India),

[22] Satish, N. S. (2020). Effect of Silver Diamine Fluoride Pretreatment on Microtensile Bond Strength of Dentin and Microleakage of Resin Composite in Primary Molars: "An in Vitro Study. Rajiv Gandhi University of Health Sciences (India),

[23] Sreejith, S. L., & Saraswathy, M. (2024). Modifications of polyalkenoic acid and its effect on glass ionomer cement. Materials Advances.

[24] Vichitgomen, J. (2020). Effect of deep margin elevation with resin composite and resin-modified glass ionomer on marginal sealing of CAD/CAM ceramic inlays: an in vitro study.

[25] Zhou, X., Huang, X., Li, M., Peng, X., Wang, S., Zhou, X., & Cheng, L. (2019). Development and status of resin composite as dental restorative materials. Journal of Applied Polymer Science, 136(44), 48180..