Available online at https://www.mmpubl.com/ijpedorehab

International Journal of Pedodontic Rehabilitation

Original Research

Comparative evaluation of microleakage of self-cure, dual-cure, and light cure glass ionomer cement in a simulated oral environment - an invitro study

Sruthi C, Chandru T P, Faizal C P, Soni K, Athira A

[1]*P G Student, Department of Paediatric & Preventive Dentistry, Kannur Dental College & Hospital, Kerala*

[2,4]*Professor, Department of Paediatric & Preventive Dentistry, Kannur Dental College & Hospital, Kerala*

[3]*Professor & HOD, Department of Paediatric & Preventive Dentistry, Kannur Dental College & Hospital, Kerala*

[5]*Senior Lecturer, Department of Paediatric & Preventive Dentistry, Kannur Dental College & Hospital, Kerala*

***How to cite: Jome J et** al, Comparative evaluation of microleakage of self-cure, dual-cure, and light cure glass ionomer cement in a simulated oral environment - an in vitro study. Int J Pedo Rehab 2024; 9(1):26-33*

DOI: https://doi.org/10.56501/intjpedorehab.v9i1.1030

Received :22/03/2024 *Accepted: 08/05/2024* *Web Published: 09/05/2024*

ABSTRACT

Background. Pediatric dentistry utilizes various restorative materials wherein the durability and longevity of these restorations hinge on the maintenance of an intact marginal seal to prevent microleakage and its associated complications. Consequently, this study aims to assess the microleakage of self-cure, dual-cure, and light-cure glass ionomer-based cements utilizing a stereo microscope.

Materials and Methods: Sixty therapeutically extracted deciduous molars were taken for the study. The restorative materials used for the studies were self-cure Glass Ionomer cement **(**Chemfil Rock and GC Fuji IX GP Fast GIC), dual cure Glass Ionomer cement (EquiaForte and Ionolux GIC), and light cure Glass Ionomer cement (GC Fuji II and Ketac N 100 GIC). All samples were stored in commercially available artificial saliva for 20 days to simulate the oral environment. The samples were immersed in Rhodamine B dye for 24 hours, and microleakage was evaluated using a Stereo microscope. Data were tabulated and statistical analysis was done. $p < 0.05$ is considered significant

Results: In the individual assessment of glass ionomer-based cement, Ketac N100 GIC exhibited the lowest microleakage, whereas Ionolux displayed higher levels of microleakage.

Conclusion: In terms of the curing method, light-cure glass ionomer cement demonstrated the least microleakage compared to both dual-cure and self-cure glass ionomer cement.

***Keywords:** Glass ionomer cement, Microleakage, Stereomicroscope*

Address for Correspondence:

Dr. Sruthi Chandran
PG Student, Department of Pediatric and Preventive Dentistry, Kannur Dental College & Hospital, Kannur, Kerala
Email: kdcpedo@gmail.com

INTRODUCTION

Over time, conventional GIC has undergone various enhancements to address the shortcomings in its physicochemical and mechanical properties. Consequently, various new types of glass ionomers have emerged, each with distinct compositions tailored to meet specific clinical requirements.[1]

Newer types of glass ionomer cement categorized into self-cure, dual-cure, and light-cure based on their adhesion to the tooth were introduced. The mechanical and chemical characteristics of these materials rely on factors such as compressive strength and resistance to microleakage.[2,3]

Chemfil Rock by Dentsply is a novel zinc-reinforced glass ionomer restorative material, claimed to have enhanced characteristics such as hardness, wear resistance, and fracture toughness. It is thought to be up to 25% stronger than alternative glass ionomer materials. Fuji IX GP Fast by GC Corporation is a self-curing, high-viscosity glass ionomer cement. Its non-adherent, dough-like texture and straightforward application method simplify minimally invasive restorations. It offers all the advantages of a glass ionomer, coupled with added benefits of easy packing and handling.[4,5]

Equia Forte by GC Corporation introduces a new glass ionomer restorative system, combining a self-adhesive, chemically cured, highly filled GIC (Fuji IX GP Extra) with a self-adhesive, light-cured, filled resin surface sealant (G-Coat Plus). Manufacturers claim increased fracture toughness, flexural strength, and flexural fatigue resistance. Ionolux by VOCO is a novel bulk placement filling material offering ion release, durability, and dual curing. It provides benefits over conventional glass ionomer blocks, such as adjustable setting time, immediate packability, fluoride release, and biocompatibility[6.] Ketac N 100 by 3M ESPE is described as a nanoionomer by the manufacturers, utilizing nanotechnology to enhance wear resistance, polishability, and esthetics. With a filler composition of 69%, it represents a new generation resin-modified glass ionomer cement. GC Fuji II LC by GC Corporation is a radiopaque, light-cured, reinforced glass ionomer cement boasting excellent aesthetics and improved abrasion resistance[7].

Limited literature exists regarding a comparative study of microleakage concerning the curing method: self-cure, dual-cure, and light-cure glass ionomer cement in a simulated oral environment. This knowledge gap prompted our research, which aims to address this issue.

MATERIALS AND METHODS

An in vitro study was conducted in the Department of Pediatric and Preventive Dentistry of a Dental College. The sample size was calculated using G* Power version 3.1 software with 80% power and 5% level of significance. The minimum sample size required was 30. The permission to conduct the study was given by the Institutional Review Board (KDC/IRB/PED19-3).

Sixty therapeutically extracted deciduous molars free from caries, developmental defects, and without hypoplasia were collected, cleaned and immersed in sodium hypochlorite for five minutes and stored in saline at room temperature. Then Samples were mounted on an acrylic block and standardized Class V cavities were prepared, approximately 4mm in length,2 mm in width, and 1.5 mm in depth on the buccal surface of teeth using a water-cooled, high–speed handpiece and fissure diamond burs.

The restoration were done with respective restorative materials which were divided into three major groups based on their nature of curing; namely group A- (self-cure)-20 teeth, group B (dual cure)-20 teeth and group C(light cure)-20 teeth, these major groups were again divided into six sub-groups comprising of two materials in each group of 10 teeth each, namely group A1 (Chemfil Rock), group A2(GC FUJI IX GP Fast), group B1(Equia Forte), group B2(Ionolux), group C1 (GC Fuji II LC) and group C2(Ketac N100).

After these all sixty restored samples were stored in commercially available artificial saliva for 20 days in order to simulate the oral environment. Samples were dried and then sealed with 2 coats of nail

https://doi.org/10.56501/intjpedorehab.v9i1.1030

varnish except 1-2mm around the margins of the restoration to limit dye penetration to the cavity margin. The following samples were immersed in Rhodamine B dye for 24 hours, later these specimens were removed from the solution, washed thoroughly using running water, and subjected for longitudinal sectioning in a buccolingual direction through the center of the restorative materials using a diamond disc. Thus, each restoration was sectioned into two equal parts for scoring leakage at the tooth-material interface. The degree of dye penetration was examined at ×30 magnification under the Stereo microscope. (Figure 2). Scoring of dye penetration was done according to a previous study by Singla T et al[9] (Table 1)

The results obtained were tabulated and subjected for statistical analysis. The data was expressed in mean and standard deviation. Statistical Package for Social Sciences (22.0) version is used for analysis. One way ANOVA (Post hoc) followed by an Independent t test applied to find the statistical significant between the groups. P value less than 0.05 is considered statistically significant.

RESULTS

Table 1 shows the inter-comparison of Microleakage between the groups. One-way ANOVA with Tukeys post hoc test was used to compare Microleakage between the groups and it was observed that there was a significant difference in Microleakage between the groups Group A [self-cure GIC] demonstrated with least Microleakage, with a mean value of 0.85±0.813 whereas Group B [dual cure GIC] demonstrated with highest Microleakage of 1.85 ±1.268 and Group C [light cure GIC] demonstrated with moderate Microleakage having mean value of 1.30 ±1.129.

SCORE 0	No dye penetration
SCORE 1	Dye penetration up to1/4 th buccal and lingual wall
SCORE 2	Dye penetration up to1/2 of buccal and lingual wall
SCORE 3	Dye penetration along the buccal /lingual wall
SCORE 4	Dye penetration up to1/4th of pulpal wall
SCORE 5	Dye penetration up to1/2 of pulpal wall

Table 1: The dye penetration scores

Table 2 shows the intra-comparison of Microleakage between the groups. One-way ANOVA with Tukey post hoc test was used to compare Microleakage between the groups and it was observed that there was a significant difference in Microleakage between the groups. Group C2(Ketac N 100) showed the least microleakage followed by Group A1(Chemfil rock), Group B1(Equia Forte), Group A2 (GC Fuji IX GP Fast), and Group C1 (GC Fuji II LC) whereas maximum Microleakage was for Group B2(Ionolux). Group A1(Chemfil rock) demonstrated a mean value of 0.50±0.52, Group A2 (GC Fuji IX GP Fast) demonstrated with a mean value of 1.20±0.91, Group B1(Equia Forte) demonstrated a mean value of 0.70±0.48, Group B2 (Ionolux) demonstrated with highest Microleakage of 3.00±0.47, Group C1 (GC Fuji II LC) demonstrated with a mean value of 2.30±0.48 whereas Group C2(Ketac N 100) demonstrated with least Microleakage, with mean value of 0.30±0.48.

https://doi.org/10.56501/intjpedorehab.v9i1.1030

	N	Mean	Std. Deviation	p-value
A	20	.85	.813	
B	20	1.85	1.268	0.019
C	20	1.30	1.129	

Table 2: Inter comparison of Microleakage between the Groups

Table 3 shows the mean comparison of Microleakage between Groups A1 (Chemfil rock) and A2 (GC Fuji IX GP Fast). Group A1 (Chemfil rock) demonstrated with a mean value of 0.50±0.52 whereas Group A2 (GC Fuji IX GP Fast) demonstrated, with mean value of 1.20±0.91. Independent t-test was used to compare Microleakage between Groups A1 (Chemfil rock) and A2 (GC Fuji IX GP Fast) and it was observed that there was no significant difference between the groups with p>0.05 indicating that Group A1(Chemfil rock) shows least Microleakage compared to Group A2(GC Fuji IX GP Fast).

	N	Mean	Std. Deviation	p-value
A1	10	.50	.527	
A2	10	1.20	.919	
B1	10	.70	.483	
B2	10	3.00	.471	<0.001
C1	10	2.30	.483	
C2	10	.30	.483	

Table 3: Intra comparison of Microleakage between the Groups

Table 4 shows the mean of Microleakage between Groups A1 (Chemfil Rock GIC) and A2 (GC Fuji IX GP Fast GIC) demonstrating with mean value of 0.50±0.527 whereas Group B2 (Ionolux) demonstrates with mean value of 1.20±0.919 Independent t-test was used to compare Microleakage between Groups and it was observed that there was a no significant difference was seen between the Groups with p>0.05 indicating that Groups A1 (Chemfil Rock GIC) shows the least Microleakage compared to A2 (GC Fuji IX GP Fast GIC).

	G	N	Mean	Std. Deviation	p-value
Microleakage	A1	10	.50	.527	0.051
	A2	10	1.20	.919	

Table 4: Comparison of Microleakage between the Groups A1 (Chemfil Rock GIC) and A2 (GC Fuji IX GP Fast GIC)

Table 5 shows the mean of Microleakage between Groups B1 (Equia Forte) and B2(Ionolux). Group B1(Equia Forte) demonstrates with mean value of 0.70±0.48 whereas Group B2 (Ionolux) demonstrates with mean value of 3.00±0.47. Independent t-test was used to compare Microleakage between Groups B1(Equia Forte) and B2 (Ionolux) and it was observed that there was a significant difference between the Groups withp<0.05 indicating that Group B1 (Equia Forte) shows the least Microleakage compared to B2(Ionolux).

	G	N	Mean	Std. Deviation	p-value
microleakage	B1	10	.70	.483	<0.001
	B2	10	3.00	.471	

Table 5: Comparison of Microleakage between the Groups B1 (Equia Forte GIC) and B2 (Ionolux GIC).

Table 6 shows the mean Comparison of Microleakage between Groups C1(GC Fuji II LC) and C2 (Ketac N 100). Group C1(GC Fuji II LC) demonstrated with a mean value of 2.30±0.48 whereas Group C2 (Ketac N 100)demonstrated with mean value of 0.30±0.48. Independent t-test was used to compare Microleakage between Groups C1(GC Fuji II LC) and C2 (Ketac N 100) and it was observed that there was a significant difference between the groups with p>0.05 indicating that group C2 (Ketac N 100) shows least Microleakage compared to C1(GC Fuji II LC).

	G	N	Mean	Std. Deviation	p-value
microleakage	C1	10	2.30	.483	<0.001
	C2	10	.30	.483	

Table 6: Comparison of Microleakage between the Groups C1 (GC Fuji II LC GIC) and C2 (Ketac N 100 GIC)

https://doi.org/10.56501/intjpedorehab.v9i1.1030

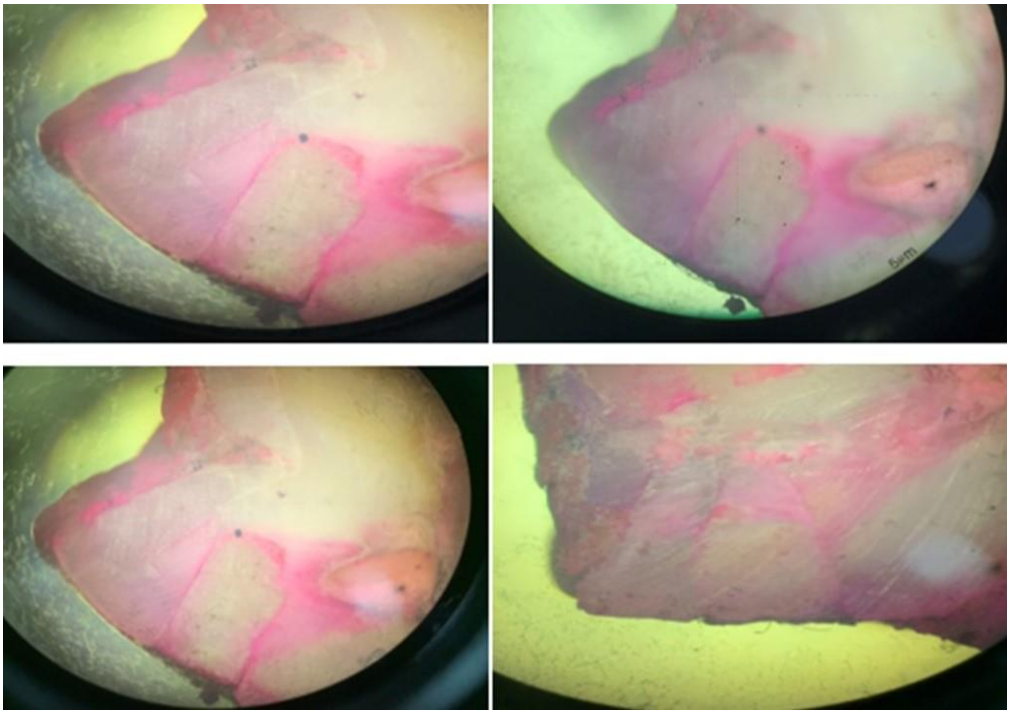

Figure 1: Stereo microscopic images of dye penetration of specimens

DISCUSSION

Microleakage is a critical factor affecting the durability of dental restorations. It leads to various issues such as staining around the restoration margins, increased sensitivity in the restored teeth, recurrent caries at the interface between the tooth and the restoration, and potential development of pulpal pathology. In this study, the extent of microleakage was evaluated using a stereo microscope, which is widely recognized as the gold standard for assessing microleakage.[10]

After assessing the microleakage of all tested glass ionomer cement, it was noted that self-cure glass ionomer cement exhibited the lowest level of microleakage, followed by light-cure glass ionomer cement and dual-cure glass ionomer cement. The reduced microleakage observed with self-cure glass ionomer cement can be attributed to its coefficient of thermal expansion, which closely matches that of tooth structures, and its low setting shrinkage. These factors contribute to better marginal sealing and minimal microleakage over time.[12]

In our study, we observed that light-cure glass ionomer cement exhibited lower microleakage compared to dual-cure glass ionomer cements. This could be attributed to the higher filler loading and lower coefficient of thermal expansion of light-cure glass ionomer cement, which helps withstand polymerization contraction stresses. Conversely, the increased microleakage observed with light-cure glass ionomer cement compared to self-cure glass ionomer cement may be due to the lower filler content of resin-modified glass ionomer (RMGI) with a higher resin content. This higher resin content can lead to increased polymerization shrinkage and, consequently, greater microleakage.[13,14]

When comparing dual-cure glass ionomer cement with self-cure and light-cure glass ionomer cement, we observed that dual-cure GIC exhibited greater microleakage. This could be attributed to the polymerization contraction stresses that occur during the restoration process.[15]

In our study, Ketac N 100 glass ionomer cement exhibited the least microleakage, followed by Chemfil Rock, Equia Forte, GC Fuji IX GP Fast, and GC Fuji II LC, while Ionolux showed the highest microleakage. The superior sealing ability of nano-ionomers may be attributed to their high filler loading and lower coefficient of thermal expansion, which help withstand polymerization contraction stresses. These findings align with previous studies conducted by Abd El Halim et al., Upadhyay et al., and Bollu et al.[17]

The higher microleakage observed with GC Fuji II LC glass ionomer cement may be attributed to its bonding mechanisms with dental structures. While the setting of resin-modified glass ionomer (RMGI) involves an acid-base reaction, a polymerization reaction occurs with 2-hydroxyethyl methacrylate (HEMA) and urethane-dimethacrylate (UDMA) monomers in the resin matrix, leading to additional shrinkage. The weaker bond strength of RMGI to enamel and dentin could contribute to increased leakage, as reported by Mitra et al. Furthermore, the formation of air bubbles during the mixing procedure and the higher resin content due to lower filler content in RMGI can exacerbate polymerization shrinkage and subsequent microleakage.[18,19]

The higher microleakage observed in Equia Forte glass ionomer compared to Ketac N 100 glass ionomer may be attributed to the influence of early water uptake on GIC materials. This uptake is typically reduced by applying protective coatings. However, in our study, the materials were tested without the application of protective coating, contrary to the manufacturer's recommendation for Equia Forte. This deviation from the recommended procedure could have contributed to the observed results.[20]

CONCLUSION

Within the constraints of this study, the following conclusions can be drawn: 1) Self-cure glass ionomer cement demonstrated the lowest level of microleakage compared to both light-cure and dual-cure glass ionomer cement. 2) In terms of individual comparison among the glass ionomer-based cement, light-cure glass ionomer cement exhibited the least microleakage, while dual-cure glass ionomer cement showed higher microleakage

FINANCIAL SUPPORT AND SPONSORSHIP

Nil

CONFLICTS OF INTEREST

There are no conflicts of interest

REFERENCES

1. Bakhadher W. Modification of glass ionomer restorative material: A review of literature. EC Dental Science. 2019;18:1001-6.
2. Hickel R, Voss A. A comparison of glass cermet cement and amalgam restorations in primary molars. ASDC J Dent Child. 1990 May-Jun;57(3):184-8.
3. Cho SY, Cheng AC. A review of glass ionomer restorations in the primary dentition. J Can Dent Assoc. 1999 Oct;65(9):491-5.
4. Seirawan MY, Doumani M, Seirawan MK, Habib A, Dayoub M. Compressive strength of three different restorative materials (in vitro study). Int J Oral Care Res. 2019 Jan 1; 7(1):4.
5. Park EY, Kang S. Current aspects and prospects of glass ionomer cements for clinical dentistry. Yeungnam Univ J Med. 2020 Jul;37(3):169-178.
6. Shah V, Dave B, Bargale S, Poonacha KS, Patel R, Chawda G. A comparative evaluation of clinical performance of conventional and light cured glass ionomer cement in class i carious lesions in primary molars- a split mouth randomized clinical study.IJDR.2018 Dec;8(12):24566-24573.
7. AlOtaibi G. Recent advancements in glass ionomer materials with introduction of nanotechnology: A review. Int J Oral Care Res. 2019 Jan 1;7(1):21**.**
8. Singla T, Pandit IK, Srivastava N, Gugnani N, Gupta M. An evaluation of microleakage of various glass ionomer based restorative materials in deciduous and permanent teeth: An in vitro study. Saudi

Dent J. 2012 Jan;24(1):35-42.

9. Crim GA. Marginal leakage of visible light-cured glass ionomer restorative materials. J Prosthet Dent. 1993 Jun; 69(6):561-3.

10. Cehreli SB, Tirali RE, Yalcinkaya Z, Cehreli ZC. Microleakage of newly developed glass carbomer cement in primary teeth. Eur J Dent. 2013 Jan;7(1):15-21.

11. Corona SA, Borsatto MC, Rocha RA, Palma-Dibb RG. Microleakage on Class V glass ionomer restorations after cavity preparation with aluminum oxide air abrasion. Braz Dent J. 2005;16(1):35-8.

12. Peker S, Giray FE, Durmus B, Bekiroglu N, Kargül B, Özcan M. Microleakage in class V cavities prepared using conventional method versus Er: YAG laser restored with glass ionomer cement or resin composite. J Adhes Sci Technol. 2017 Mar 4; 31(5):509-19

13. Gerdolle DA, Mortier E, Droz D. Microleakage and polymerization shrinkage of various polymer restorative materials. J Dent Child (Chic). 2008 May-Aug;75(2):125-33.

14. Davidović L, Tomić S, Stanojević M, Živković S. Microleakage of glass ionomer cement restorations. Stomatol. Glas. Srb. 2009; 56(2):78-85**.**

15. Naghma P, Bilal A, M Amjad B, Anser M. Comparison of microleakage in resin modified glass ionomer cements and poly acids modified composites [compomers]. Pak Oral Dental J. 2009; 29 (2): 379-384.

16. Bollu IP, Hari A, Thumu J, Velagula LD, Bolla N, Varri S, Kasaraneni S, Nalli SV. Comparative evaluation of microleakage between nano-ionomer, giomer and resin modified glass ionomer cement in class V cavities-CLSM study. JCDR. 2016 May; 10(5):ZC66**.**

17. Perdigão J, Dutra-Corrêa M, Saraceni SH, Ciaramicoli MT, Kiyan VH. Randomized clinical trial of two resin-modified glass ionomer materials: 1-year results. Oper Dent. 2012 Nov-Dec;37(6):591-601

18. Abd El Halim S, Zaki D. Comparative evaluation of microleakage among three different glass ionomer types. Oper Dent. 2011 Jan-Feb;36(1):36-42.

19. Upadhyay S, Rao A. Nanoionomer: evaluation of microleakage. J Indian Soc Pedod Prev Dent. 2011 Jan-Mar;29(1):20

20. Toras FM, Hamouda IM. Effect of nano filler on microhardness, diametral tensile strength and compressive strength of nano-filled glass ionomer. Int J Dentistry Oral Sci. 2017 Feb 8;4(2):413-7**.**

Published by MM Publishers
https://www.mmpubl.com/ijpedorehab