ISSN: 2230-9926

Available online at http://www.journalijdr.com

IJDR

International Journal of Development Research
Vol. 08, Issue, 12, pp.24566-24573, December, 2018

ORIGINAL RESEARCH ARTICLE OPEN ACCESS

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

***Dr. Vaishnavi Shah, Dr. Bhavna Dave, Dr. Seema Bargale, Dr. Poonacha KS, Dr. Roshani Patel and Dr. Gaurav Chawda**

Department of Paedodontics & Preventive Dentistry, K.M. Shah Dental College and Hospital, Sumandeep vidhyapeeth, Piparia, Vadodara

ARTICLE INFO

Article History:
Received 28th September, 2018
Received in revised form
10th October, 2018
Accepted 06th November, 2018
Published online 26th December, 2018

Key Words:
Primary molars, Clinical trial,
Glass ionomer cement.

ABSTRACT

Glass ionomer cement is dental restorative material used in paediatric dentistry for dental fillings over more than 20 years. Its usefulness in paediatric dentistry is preferential because of its fluoride release, chemical adhesion to tooth structure, and availability to use in all clinical scenarios. Ionolux-Light-curing glass ionomer restorative material, is a new basic filling material offering advantages over conventional glass ionomer cements. This study was conducted to compare and evaluate the clinical performance of conventional glass ionomer cement and light cured glass ionomer cement in class I carious lesions in primary molars. Total 23 patients (46 teeth) who reported the OPD of Department of pedodontics & Preventive Dentistry, K. M. Shah Dental College and Hospital, Vadodara were included in the study. Patients had to have one or more pair of contralateral teeth indicated for Class I restorations. The two materials, Conventional GIC(d-tech) andlight cured GIC (Ionolux) were randomly placed in a split mouth design. The restorations were evaluated usingmodified USPHS criteria after 24 hours, 3 months, 6 months and 9 months.Evaluation of the restorations was done by mouth mirror and probe under dental chair light. Data were subjected to statistical analysis**.** A Mann Whitney U- test and Friedman test were performed to assess intra and inter group differences. Colour Match, Marginal Discolouration, Anatomic Form, Marginal adaptation, Surface texture, Secondary caries and Post-operative sensitivity were assessed for all the participants. The result did not reflect any significant differences at 24 hours follow-up; however, change appeared at 3, 6 and 9 months. Success rate remained similar for both although it remained constant only for Light cured GIC. Light cured Glass ionomer cement can be recommended for Class I restorations in clinical set ups as well as community-based field programs.

Citation: Dr. Vaishnavi Shah, Dr. Bhavna Dave, Dr. Seema Bargale, Dr. Poonacha KS, Dr. Roshani Patel and Dr. Gaurav Chawda. 2018. "A comparative evaluation of clinical performance of conventional and light cured glass ionomer cement in class i carious lesions in primary molars- a split

INTRODUCTION

Despite the evolution of dentistry in the field of oral health for children, tooth decay remains the most common childhood disease. Restoring carious teeth is one of the major treatment needs in paediatric dentistry (Roberts, 2005 and Verma, 2006). Dental amalgam has served as an excellent and versatile restorative material for many years. However, it has many drawbacks like lack of aesthetics and the unavoidable use of mercury, which may be regarded as harmful component to the patient's health. This leads to search more improved materials (FDI World Dental Federation, 2014).

****Corresponding author:*** **Dr. Vaishnavi Shah**
Department of Paedodontics & Preventive Dentistry, K.M. Shah Dental College and Hospital, Sumandeep vidhyapeeth, Piparia, Vadodara.

The ideal requisites for a restorative material are that it should have good colour stability, biocompatibility, have a co-efficient of thermal expansion similar to that of natural tooth structure, excellent marginal seal and should have the ability to adhere chemically to both enamel and dentin. Some of their physical and chemical properties make glass ionomer cements excellent dental restorative materials for paediatric patients. They provide a slow release of fluoride that produces a cariostatic action; chemically bind to enamel and dentin, thereby reducing the need for the retentive cavity preparation; and, are biocompatible with pulpal tissue (Antonucci, 1988 and Lim *et al*., 1999). A glass ionomer cement is a dental restorative material used in dentistry for dental fillings and luting cements. Glass ionomer cements (GIC) have been used in Paediatric restorative dentistry for 20 years. Their usefulness in paediatric restorative dentistry is preferential

relative to other materials because of their properties and availability to use in a variety of clinical scenarios (McCabe, 2008). The glass ionomer cement (GIC) was developed with the objective to produce a restorative material that would possess the desirable properties of silicate cements and polycarboxylate cement. Conventional GICs have certain properties that make them useful as a restorative material of choice (Morabito, 1997). However, some deficiencies like attack by moisture during the initial setting period, short working time, long setting and maturation time, have low fracture toughness, and exhibit lower wear resistance have limited their use to areas which are not subjected to masticatory stresses, because of these reasons associated with the traditional glass ionomer cements, the technology of hybrid versions of the material which are light cured was introduced (Antonucci, McKinney and Stansbury) (Antonucci, 1988 and Lim, 1999). These materials were classified as resin-modified glass-ionomer cements (RMGICs) and compomers. The resin was incorporated in the glass ionomers to protect the chemical cure mechanism in the latter so that immediate finishing can be carried out. It was developed to overcome the problems of moisture sensitivity and low initial mechanical strengths typical for conventional glassionomers. Resin-Modified Glass Ionomer Cements (RMGICs) are based on the reaction of silicate glass powder (calciumaluminofluorosilicate glass) and polyalkenoic acid, an ionomer (Sonis, 2003).

In thinking of restorative objectives for children, one must consider several general categorical objectives. Sealing the cavity, preventing further tooth destruction, rendering the tooth and the tooth-restoration interface caries resistant, and ease of use in a clinical scenario must be included. In addition, the material selected for the procedure must endure the gruelling environment of the mouth for the period in which it is intended to be effective. As discussed in the 6 literature review on this subject by Croll, Light cured glass ionomers meet the objectives set forth here (Kenneth, 2003 and Croll, 1993). For children, these materials have offered an alternative that has insidiously become a "standard of care" in a variety of clinical indications for children. As a restorative material, Light cured glass ionomer cements – a cost-effective, fluoride releasing product that is quick and easy to use without complicated equipment and that offers both strength and good aesthetics.

Ionolux- Light-curing glass ionomer restorative material, a new basic filling material offering advantages over conventional glass ionomer cements.

- Excellent working time – setting time individually adjustable by light-curing.
- No need for conditioning of dental hard tissue.
- Also, suitable for big cavities.
- Immediately packable after placement in the cavity.
- Does not stick to the instrument, easy to mode.
- Fill, polymerize and finish – no varnish required.
- Fluoride release.
- Biocompatible.
- Radiopaque.
- A suitable alternative to the CBF technique (composite bonded to flow) in deep cavities.

Ionolux thus redefines the basic filling, combining bulk placement, ion release, and durability in a dual-curing, aesthetic product - satisfying the demands of both dentists and patients.

Null Hypothesis: There will be no difference between clinical performance of conventional glass ionomer cement and Light cured glass ionomer cement in primary molars with class I carious lesions using modified USPHS criteria at all 3 different.

SUBJECTS AND METHODS

This study was Prospective Randomized Study conducted in the Department of Paedodontics & Preventive Dentistry, K. M. Shah Dental College and Hospital, Sumandeep Vidyapeeth. The study was approved by the institutional ethical committee (SVIEC/ON/Dent/SRP/18108). A Total of 46 primary molars (23 children) indicated for class I restorations were selected as a sample size in healthy patients aged between 4 and 8-year-old children from the OPD of Department. The patient's guardians were informed of the study purposes, procedures and a written informed consent was signed by all patients' guardians. The study included Participants with minimum bilateral and contralateral Class I carious lesion with no history of spontaneous pain, no tenderness to palpation or percussion, free of abscess or fistula, no abnormal mobility, radiographic evidence of intact lamina dura, no radiographic evidence of internal root resorption or inter-radicular orperiapical pathosis. The tooth should be in occlusion, with opposing and adjacent teeth. Patients with heavy bruxism or malocclusion were excluded. The care was taken not to include patient havingany syndrome or systemic diseases.

All restorations were placed by one operator to maintain the standard procedure. Radiograph was taken for each primary molar before starting the procedure. All the subjects were undergoing the clinical procedure using a split mouth technique where one side (Left or Right) primary molar was filled with conventional GIC restoration and the other side primary molar was filled with light cured (LC) GIC restoration. The right/left side of selection for the restoration with either of the material was done with flip coin method to avoid the bias and have randomized samples for both the groups. The participants were blinded for the material used, howeverfor convenience for the operator, the conventional GIC restoration was termed as group A and the LC GIC restoration was termed as group B in the same mouth. After proper isolation, Clinical procedure comprised of conventional Class–I cavity design as given by Dr.G.V. Black using appropriate armamentarium for both Group A and B. The access to Class I cavities were made using high-speed water-cooled Carbide Burs No. 330 approximately with the depth of 0.5 mm in dentine. A new bur was used every six preparations.

The preparation design was dedicated by the extent of the decay. Prepared Class I cavities were rinsed for 20 seconds with air-water spray and gently air-dried before the placement of the restorations All teeth were filled with either of the materials according to flip coin method. GIC material in the liquid/powder ratio (According to manufacturer's instructions) was hand mixed with the help of agate spatula. After Mixing, the material was transferred into the Class I cavity prepared and was condensed, polished. Coco butter was applied on the restoration to avoid change in physical property of material and also to avoid contamination with saliva. The procedure was same for both the materials except the LC GIC was set by curing the material according the manufacture's advice (curing time).

Figure 1. Pre-operative with bilateral occlusal caries

Figure 2. Next day follow up the right quadrant filled with LC GIC and conventional GIC on the left quadrant

Figure 3. At 3 months follow up the right quadrant filled with LC GIC and conventional GIC on the left quadrant

Figure 4. At 6 months follow up the right quadrant filled with LC GIC and conventional GIC on the left quadrant

Figure 5. At 9 months follow up the right quadrant filled with LC GIC and Conventional GIC on the left quadrant

Table 1 shows Children distribution according to child's age and gender

Gender	Number (n)				Total
	5 Years	6 Years	7 Years	8 Years	
Male	1	3	2	4	10
Female	3	2	5	3	13
All Children	4	5	7	7	23

The records were kept by the assistant for all the participants. The occlusion was checked and adjusted using articulating paper. The restorations were finished at the same visit using standardized procedures starting from the course, medium and then fine diamond abrasive burs. Finally, the restorations were accomplished with polishing burs. The patient was recalled on the next day, 3 months, 6 months and 9 months for clinical evaluation. The co- investigator was evaluating the restorations by mouth mirror and probe by evaluator using modified USPHS criteria which include aesthetic, functional, and biological properties on the next day, 3 months, 6 months and 9 months.

RESULTS

On next day, after 3, 6 and 9 months, the data obtained were statistically analysed using SPSS version 18.0 program (SPSS IBM Inc.). A Mann-Whitney U-test was performed to identify differences in USPHS score between conventional GIC and LC GIC. All details regarding patient's age, gender, and the distribution of the treated teeth as per number of teeth and the type of restoration is presentedin. Tables 1 & 2. Clinically, excellent results were noted for the three main properties of the modified USPHS criteria at next day, 3 months, 6 months and 9-monthsrecall for the conventional glass ionomer cement and light cured glass ionomer cement. (Table-3,4,5,6 and Graph-1,2 and 3).

Table 2. Shows Restoration distribution according to tooth type and restoring material

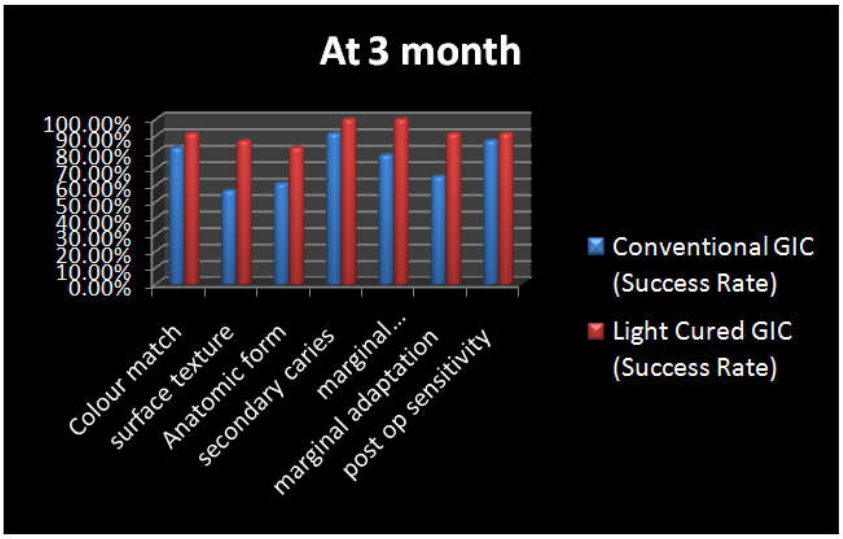
Restoring Material	Number (n)		Total
	First deciduous molar	Second deciduous molar	
Conventional glass ionomer cement	7	16	23
Light cured glass ionomer cement	7	16	23
All restorations	14	32	46

Table 3. Shows Mann-Whitney U-test results to assess the significant differences between Conventional GIC group and Light Cured GIC group according to studied period and studied criterion at 24 hours

Criterion	Sub criterion	At 24 Hr				p value
		Conventional GIC (Success Rate)		Light Cured GIC (Success Rate)		
Esthetic Properties	Colour Match	23	100.00%	23	100.00%	1.000
	Marginal Discolouration	23	100.00%	23	100.00%	1.000
	Anatomic Form	23	100.00%	23	100.00%	1.000
Functional Properties	marginal adaptation	23	100.00%	23	100.00%	1.000
	surface texture	23	100.00%	23	100.00%	1.000
Biological Properties	secondary caries	23	100.00%	23	100.00%	1.000
	post op sensitivity	23	100.00%	23	0.100.00%	1.000

Table 4. shows Mann-Whitney U-test results to assess the significant differences between Conventional GIC group and Light Cured GIC group according to studied period and studied criterion after 3 months

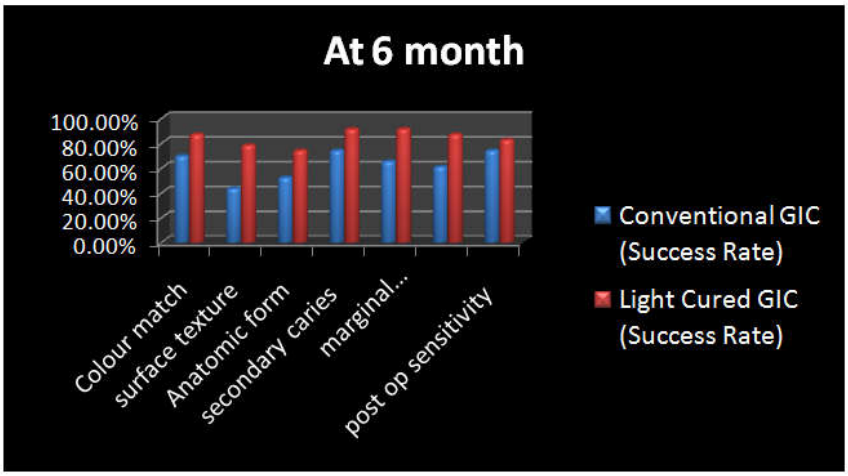
Criterion	Sub criterion	After 3 months				p value
		Conventional GIC (Success Rate)		Light Cured GIC (Success Rate)		
Esthetic Properties	Colour Match	19	82.61%	21	91.30%	0.386
	Marginal Discolouration	18	78.26%	23	100.00%	0.018
	Anatomic Form	14	60.87%	19	82.61%	0.105
Functional Properties	marginal adaptation	15	65.22%	21	91.30%	0.045
	surface texture	23	100.00%	23	100.00%	1.000
Biological Properties	secondary caries	21	91.30%	23	100.00%	0.153
	post op sensitivity	20	86.96%	21	91.30%	0.639



Graph 1. Significant differences between Conventional GIC group and Light Cured GIC group according to studied period and studied criterion at 3 months

Table 5. Showsmann-Whitney U-test results to assess the significant differences between Conventional GIC group and Light Cured GIC group according to studied period and studied criterion after 6 months

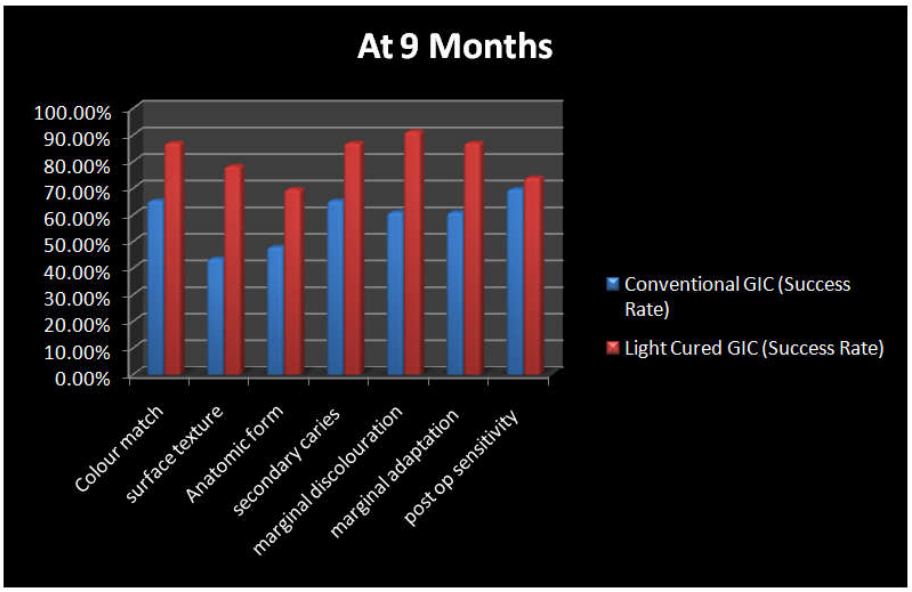
Criterion	Sub criterion	After 6 months				p value
		Conventional GIC (Success Rate)		Light Cured GIC (Success Rate)		
	Colour Match	16	69.57%	20	86.96%	0.157
	Marginal Discolouration	15	65.22%	21	91.30%	0.034
Esthetic Properties	Anatomic Form	12	52.17%	17	73.91%	0.073
Functional	marginal adaptation	14	60.87%	20	86.96%	0.046
Properties	surface texture	10	43.48%	18	78.26%	0.024
Biological	secondary caries	17	73.91%	21	91.30%	0.124
Properties	post op sensitivity	17	73.91%	19	82.61%	0.483



Graph 2. Significant differences between Conventional GIC group and Light Cured GIC group according to studied period and studied criterion at 6 months

Table 6. shows Mann-Whitney U-test results to assess the significant differences between Conventional GIC group and Light Cured GIC group according to studied period and studied criterion after 9 months

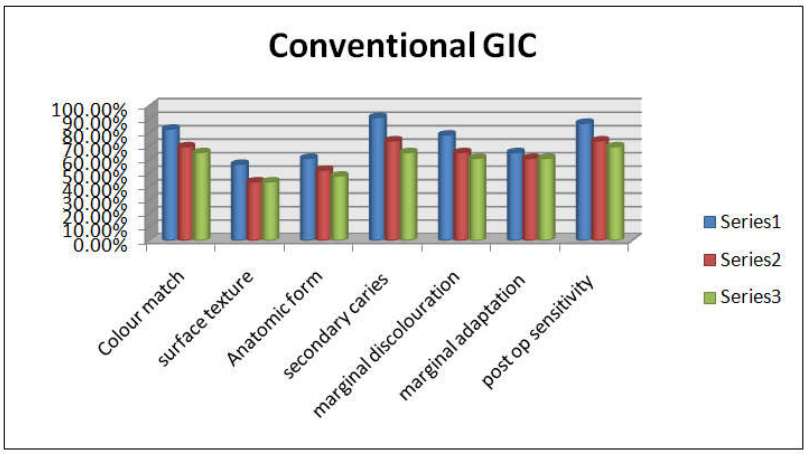
Criterion	Sub criterion	After 9 months				p value
		Conventional GIC (Success Rate)		Light Cured GIC (Success Rate)		
Esthetic Properties	Colour Match	15	65.22%	20	86.96%	0.087
	Marginal Discolouration	14	60.87%	21	91.30%	0.017
	Anatomic Form	11	47.83%	16	69.57%	0.072
Functional Properties	marginal adaptation	14	60.87%	20	86.96%	0.046
	surface texture	10	43.48%	18	78.26%	0.024
Biological Properties	secondary caries	15	65.22%	20	86.96%	0.087
	post op sensitivity	16	69.57%	17	73.91%	0.707



Graph 3. Significant differences between Conventional GIC group and Light Cured GIC group according to studied period and studied criterion at 9 months

Table 7. Shows Friedman Test results to assess the significant differences at 3, 6 and 9 months of Conventional glass ionomer cement

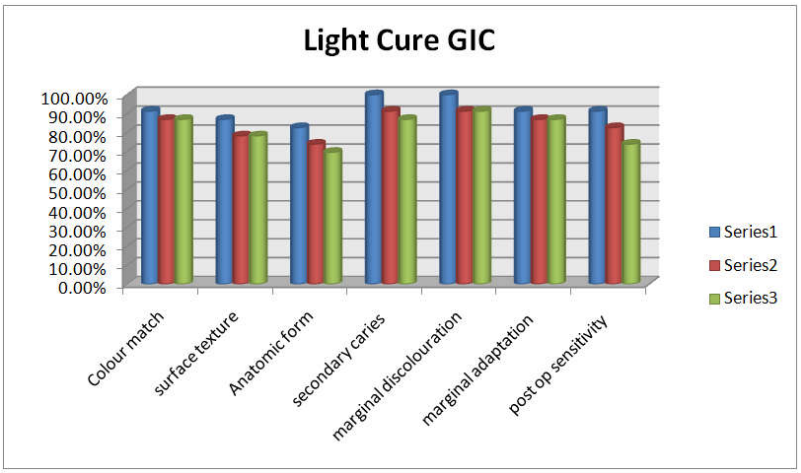
Category	Conventional GIC (Success Rate) At 3 months		Conventional GIC (Success Rate) At 6 months		Conventional GIC Success Rate) At 9 months		p value (Friedman Test)
Colour match	19	82.61%	16	69.57%	15	65.22%	0.039
surface texture	13	56.52%	10	43.48%	10	43.48%	0.001
Anatomic form	14	60.87%	12	52.17%	11	47.83%	0.002
secondary caries	21	91.30%	17	73.91%	15	65.22%	0.009
marginal discolouration	18	78.26%	15	65.22%	14	60.87%	0.039
marginal adaptation	15	65.22%	14	60.87%	14	60.87%	0.135
post op sensitivity	20	86.96%	17	73.91%	16	69.57%	0.002



Graph 4. shows Friedman Test results to assess the significant differences at 3, 6 and 9 months of Conventional glass ionomer cement

Table 8. Shows Friedman Test results to assess the significant differences at 3, 6 and 9 months of Light cured glass ionomer cement

Category	Light Cured GIC (Success Rate) At 3 months		Light Cured GIC (Success Rate) At 6 months		Light Cured GIC (Success Rate) At 9 months		p value (Friedman Test)
Colour match	21	91.30%	20	86.96%	20	86.96%	0.368
surface texture	20	86.96%	18	78.26%	18	78.26%	0.018
Anatomic form	19	82.61%	17	73.91%	16	69.57%	0.097
secondary caries	23	100.00%	21	91.30%	20	86.96%	0.097
marginal discolouration	23	100.00%	21	91.30%	21	91.30%	0.135
marginal adaptation	21	91.30%	20	86.96%	20	86.96%	0.368
post op sensitivity	21	91.30%	19	82.61%	17	73.91%	0.009



Graph 5. Shows Friedman Test results to assess the significant differences at 3, 6 and 9 months of Light cured glass ionomer cement

Table 7 and Graph 4 showed significant differences at 3, 6 and 9 months of Conventional glass ionomer cement. Table- 8 and Graph-5 showed significant differences at 3, 6 and 9 months of light cured glass ionomer cement. At 3 and 6months' statistical significance change seen in marginal discolouration and marginal adaptation in conventional GIC. At 9 months' light cured glass ionomer restorations showed clinical excellent results where conventional GIC showed significant difference in marginal discolouration, marginal adaptation and surface texture. Statistical analysis revealed that there were significant differences in USPHS scores for sub-mentioned criteria at 9 months as $p < 0.05$ with a confidence level of 95%.

DISCUSSION

Nowadays, a lot of researches are being conducted to identify the ideal aesthetic restorative material to be used in restoring carious primary teeth.

Conventional GIC is a technique sensitive material that requires efficient moisturecontrol and high standard of patient cooperation in this perspective LCGI was introduced (Ghaderi, 2015 and Soncini, 2007). Several attempts were conducted to enhance the mechanical and aestheticproperties of GI restorations as it is characterized by its simple manipulation, biocompatibility, and fluoride releasing property. Therefore, this study was carried out to compare the clinical performance of two materials conventional GIC (GC Fuji II) and LC GIC (Voco Ionolux). Anatomically, the primary teethhave thinner enamel and dentin, Pulp horns are higher and the pulpal floor is slightly concave as compare to permanent teeth which increases the incidence of the occlusal cavity in primary teeth (Dean, 2011). This study evaluated the clinical performance of LC GIC cement in Class Ion primary teeth since, it was shown to be an effective restoration for permanent teeth (Giray, 2014) and very few documented clinical trials have been conducted

on primary teeth. In this study split mouth design was taken and lottery method was chosen to expose the two restorative materials to nearly identical oral environmental conditions and to eliminate any bias due to patient variables. In most cases, the requirement for inclusion was the presence of at least two dentin lesions in need of restorative treatment, and because of this, in general the patients represented a group with a relatively high caries activity (reflected by a high caries experience). The children were also relatively young at the time of restoration – 4–8 years. It might be expected that this would have an effect on the success rates. However, neither the age nor the caries experience of the child at the time of restoration significantly influenced the success rates. Other studies done by S. Hube *et al*. and Salma Hamie *et al*. had also used split mouth technique to reduced bias (Hubel, 2003 and Salma Hamie, 2017).

In this study 4 to 8 years of age group was selected due to exfoliation of the primary teeth, and follow up was taken till 9 months as followup times in clinical trials on the survival of restorations in primary molars are often short and include a number of censored teeth. For example, Andersson wenckert *et al*. (Andersson-Wenckert, 1995) and Qvist *et al*. (1997) reported that about 1/3 of the restorations were censored because of exfoliation during an observation period of 2-3 years. In contrast, the relatively low age of the children at the time of restoration in the present study meant that a majority of the successful restorations could be followed for 9 months. Hence, the number of censored teeth was relatively low. USPHS criterion is a long-standing method for the evaluation of dental restorations in clinical trials. There are some concerns about the sensitivity of the approach in short-term clinical evaluations. However, this scoring system is still being used in the clinical trials to compare outcomes. This method remains the most commonly used for evaluating important characteristics of dental restorations, such as postoperative sensitivity, secondary caries, marginal discoloration, adaptation, and colour match, and it is able to generate data that are of a clinical relevance (Roland Frankenberger, 2009 and Celik, 2010). Clinical evaluation and radiographic assessment of conventional and LCGI restoration was done at next day, 3 months, 6 months and 9 months. Radiographic assessment was based on the recommendation of the AAPD, to avoid excessive radiation exposure. The restorations were evaluated for restoring functional, biological form and aesthetic properties. There is lake of in vivo study comparing conventional GIC and LCGIC. The results of this study revealed clinically excellent for both restorative materials for the three main properties of the USPHS criteria up to next day but conventional GIC was showed a statistical significance at 3,6 and 9 months in Marginal discolouration and Marginal adaptation and Surface texture.

Rani Somani *et al*. (Rani Somani, 2016), evaluated Shear bond strength of conventional and LCGIC to dentin of primary teeth and they concluded that LC GIC was significantly better than conventional GIC in terms of shear bond strength and these results came in accordance with other study done by Poggio *et al*. (Poggio, 2014). The clinical success of restorative material depends upon a good adhesion with dentinal surface so as to resist various dislodging forces acting within the oral cavity. The better performance of LC GIC is due to their expected dual mechanism of adhesion or enhanced mechanical properties. The adhesion is probably through a combination of a dynamic ion exchange process and micromechanical bonding mechanism (Prabhakar, 2003). Mathis, Ferracane considered that the enhanced mechanical properties are due to the fact that the resin acts as a reinforcing agent, resulting in significantly higher initial properties, fracture toughness during desiccation, and decreased solubility. It rapidly hardens by visible light, has shorter setting time, decreased early moisture sensitivity, extended working time, greater strength, and enhanced mechanical and physical properties (Pisanechi, 1997). Conventional GIC is a product of an acid-base reaction between basic fluoroaluminosilicate glass powder and polycarboxylic acid. Its mechanism of bonding is based on bond formation between carboxyl groups of polyacrylic acid with hydroxyapatite at the tooth surface. The lowest shear bond strength was observed for conventional GIC by Rani Somani *et al*. (Rani Somani, 2016). It could be because they are susceptible to attack by moisture during the initial setting period. They have short working time, long setting and maturation time. Furthermore, they are susceptible to fracture and exhibit low wear resistance. They have inferior mechanical properties like low fracture toughness, tensile strength, and brittleness as compared to LC GIC.

LC GIC superior performance was also pointed out by S. Hube *et al*. (Hubel, 2003), when they assessed the survival rates of conventional and resin-modified GIC in primary molars for 3-year using USPHS criteria. They determined the success rate of LC GIC (94%) and conventional GIC restorations (81%). This superior performance was noted due to the resin content which enhanced the physical property, in addition to light curing property which provided the immediate setting. This is in agreement with previous results where conventional GIC materials showed failure rates of 20–60% after 2–3 years (Qvist, 1997 and Andersson-Wenckert, 1995 and Ostlund, 1992) whereas corresponding failure rates of RMGIC materials were 2–20% (Espelid, 1999; Qvist, 2001 and Folkesson, 1999). In this study, however, no case of endodontic complication was observed.

This study has the following limitations

- The wear criterion was not measured quantitatively using 3D laser scanning
- Nine months are a relatively short period to evaluate the long term dental adhesive materials.

Conclusion

Despite the study limitations, it can be concluded that The light cured GICs offered advantages over the conventional GICs for restoring caries in primary molars. Light cured GICrestorative material performed satisfactorily over 9 months. Moreover, Conventional GIC restoration is an acceptable material that can be used in primary teeth which are near to exfoliate.

- Further investigations with larger sample size and longer follow‑up period would be indicated for better performance assessment of such restorations in the long‑term
- In addition, an in vitro study should be conducted after teeth shedding to give more details.

Importance of this study for paediatric patients

To evaluate which material‑ conventional or light cured GI will provide better clinical performance for pediatric patients in its esthetic, functional, and biological properties.

To help pediatric dentists choose a better restorative material for Class I cavities in primary molars. Light cured GI couldbe recommended for Class I restorations, for ART or IRT due to its anticariogonicity and friendly technique of application which makes it suitable for uncooperative patients.

REFERENCES

Andersson-Wenckert IE, Dijken van JWV, Stenberg R. Effect of cavity form on the durability of glass ionomer cementrestorations in primary teeth: a three-year clinical evaluation. *Journal of Dentistry for Children* 1995; 62: 197–200.

Antonucci JM, McKinney JE, Stansbury JW. Resin modified glass ionomer dental cement, 1988. U.S. Patent 160856.

Celik C, Arhun N, Yamanel K. Clinical evaluation of resin-based composites in posterior restorations: 12-month results. *Eur J Dent.*, 2010;4:57–6.

Croll, TP. The No Boring Science Take Care of Your Kid's Mouth Book. American Society of Dentistry for Children Publications; 1993.

Dean JA, Avery DR, Mcdonalds RE. Dental caries in the child and adolescent. In: Hunter ML, editor. McDonald and Avery's Dentistry for the Child and Adolescent. 9th ed. Pennsylvania, USA: Taylor & Francis Ltd.; 2011. p.373.

Espelid I, Tveit AB, Tornes KH, Alvheim H. Clinical behaviour of glass ionomer restorations in primary teeth. *Journal of Dentistry* 1999; 27: 437–442.

FDI World Dental Federation. FDI policy statement on dental amalgam and the Minamata Convention on Mercury: Adopted by the FDI General Assembly: 13 September 2014, New Delhi, India. Int Dent J 2014;64:295‑6.

Folkesson UH, Andersson-Wenckert IE, van Dijken JWV. Resin-modified glass ionomer cement restorations in primary molars. *Swedish Dental Journal* 1999; 23: 1–9.

Ghaderi F, Mardani A. Clinical success rate of compomer and amalgam class II restorations in first primary molars: A two‑year study. *J Dent Res Dent Clin Dent Prospects* 2015; :92‑5.

Giray, F.E., S. Peker, B. Durmus, B. Kargul. Microleakage of new glass ionomer restorative materials in permanent teeth. *EuropEan Journal of paediatric dentistry*., vol. 15/2-2014,122-6.

Hubel, S. & I. Mejare. Conventional versus resin-modified glass-ionomer cement for Class II restorations in primary molars. A 3-year clinical study. *International Journal of Paediatric Dentistry.*, 2003; 13:2–8.

Kenneth J. 2003. Phillips' Science of Dental Materials (11 ed.). United Kingdom: Elsevier Health Sciences. pp. 471–472. 4.

Kilpatric NM, Murray JJ, McCabe JF. The use of a reinforced glass-ionomer cermet for the restoration of primary molars: a clinical trial. *British Dental Journal*., 1995; 179: 175–179.

Lim CC, Neo J, Yap A. The influence of finishing time on the marginal seal of a resin-modified glass-ionomer and polyacid-modified resin composite. *J Oral Rehabil* 1999; 26:48-52.

McCabe, John F.; Walls, Angus W.G. 2008. Applied Dental Materials (9 ed.). Oxford, United Kingdom: Wiley-Blackwell (an imprint of John Wiley & Sons Ltd). pp. 284–287.

Morabito A, Defabianis P. The marginal seal of various restorative materials in primary molars. Journal of Clinical Pediatric Dentistry 1997; 22: 51–54.

Ostlund J, Möller K, Koch G. Amalgam, composite resin and glass ionomer cement in Class II restorations in primary molars – a three-year clinical evaluation. *Swedish Dental Journal*., 1992; 16: 81–86.

Pisanechi E, de Carvalho RCR, Matson E. Shear bond strength of glass ionomer cements to dentin. Effects of dentin depth and type of material activation. *Rev Odontol Univ Sao Paulo.* 1997;11(Suppl):1–7

Poggio C, Beltrami R, Scribante A, Colombo M, Lombardini M. Effects of dentin surface treatments on shear bond strength of glass-ionomer cements. *Ann Stomatol (Roma)* 2014 Jan-Mar;5(1):15–22.

Prabhakar AR, Raj S, Raju OS. Comparison of shear bond strength of composite, compomer and resin modified glass ionomer in primary and permanent teeth. An in vitro study. *J Indian Soc PedoPrev Dent*. 2003 Sep;21(3):86–94.

Qvist V, Laurberg L, Poulsen A, Teglers PT. Longevity and cariostatic effects of everyday conventional glass-ionomer and amalgam restorations in primary teeth: Three-year results. *Journal of Dental Research* 1997; 76: 1387–1396.

Qvist V, Laurberg L, Poulsen A, Teglers PT. Resin-modified glass ionomer and compomer restorations in primary teeth. Five to six years results. *Journal of Dental Research* 2001; 80: 642 (Abstract no. 921).

Rani Somani, Shipra Jaidka, Deepti J Singh and Gurleen K Sibal.Comparative Evaluation of Shear Bond Strength of Various Glass Ionomer Cements to Dentin of Primary Teeth: An in vitro Study. *Int J Clin Pediatr Dent.* 2016 Jul-Sep; 9(3): 192–196.

Roberts JF, Attari N, Sherriff M. The survival of resin modified glass ionomer and stainless steel crownrestorations in primary molars, placed in a specialist paediatric dental practice. *Br Dent J* 2005; 198:427‑31.

Roland Frankenberger, Franklin Garcia-Godoy and Norbert Kramer. Clinical Performance of Viscous Glass Ionomer Cement in Posterior Cavities over Two Years. *International Journal of Dentistry.* December 2009;

Salma Hamie, Sherine Badr, Hala Ragab. Clinical and Radiographic Evaluation of Glass Ionomer Compared to Resin Composite in Restoring Primary Molars: A 1‑year Prospective Randomized Study. *Journal of Pediatric Dentistry* | Volume 5; Issue 1: January-April 2017: 6-13.

Soncini JA, Maserejian NN, Trachtenberg F,Tavares M, Hayes C. The longevity of amalgam versus compomer/composite restorations inposterior primary and permanent teeth: Findings from the NewEnglandchildren's amalgam trial. *J Am Dent Assoc.,* 138:763‑72.

Sonis, Stephen T. 2003. Dental Secrets (3 ed.). Philadelphia: Hanley & Belfus. p. 158.

Verma P, Shetty V, Hegde AM. Propylthiouracil (PROP) – A tool to determine taster status in relation to caries experience, streptococcus mutans levels and dietary preferences in children. *J Clin Pediatr Dent* 2006; 31:113‑7.

****