AJDS ALAZHAR
Al-Azhar Journal of Dental Science
Vol. 24- No. 1- 85:91- January 2021
Print ISSN 1110-6751 | online ISSN 2682 - 3314
azhar.dent.j@azhar.edu.eg
Pediatric Dentistry & Orthodontics *(Pediatric Dentistry, Orthodontics)*

EVALUATION OF ZIRCONIA INFUSED GLASS IONOMER CEMENT VERSUS RESIN MODIFIED GLASS IONOMER IN CLASS II RESTORATIONS OF PRIMARY MOLARS.

Mohamed Saber Abd Elghaffour Elsawy*, Ibrahim Farouk Barakaty**, Tamer Abd El-Lateef El Mansy***, Muhammad Abbas Masoud ****

ABSTRACT

Objective: The objective of this study to was to evaluate zirconia infused glass ionomer cement versus resin modified glass ionomer in class II restorations of primary molars. **Materials and Methods**: This study was classified in to vivo and vitro study. I- vivo study: 18 posterior primary molars from 9 children by using split mouth technique was classified equally in to two groups. Group 1: 9 deciduous molars were restored with resin-modified glass-ionomer (RMGI) filling. Group 2: 9 deciduous molars were restored with zirconia infused glass-ionomer (ZRGI) filling. Follow up using the FDI criteria to evaluate the clinical performance of both materials. II- vitro study: 18 freshly extracted human deciduous molars with no crack, decay or structure deformities were collected and stored in normal saline. Group 3: 9 extracted deciduous molars were restored with resin-modified glass-ionomer filling. Group 4: 9 extracted deciduous molars were restored with zirconia- infused glass-ionomer filling. The measures were calculated by Shear bond strength and Wear resistance calculation. **Results:** It was found that that RMGI is better in shear strength than zirconia infused glass ionomer, while the two materials have the same resistance to wear. **Conclusion**: Shear Bond strength of RMGI is better than zirconomer. There is no significant difference in wear resistance between the two materials. Clinical performance of RMGI is better than zirconomer.

KEYWORDS: deciduous molars, RMGI, ZRGI.

INTRODUCTION

Restorative dentistry is a blend of science and art. The triumph of restorative dentistry is based on the functional and esthetic results of a given intervention. The foundation for aesthetics in the sequence is laid by position, contour, texture, and color [(1)]. Glass ionomer cement (GIC) was the one of the first aesthetic restorative materials introduced in the dental field by Wilson and Kent way back in 1972 [(2)].

The added advantages of active fluoride release and chemical adhesion further justified the extensive usage of GIC in young children. Therefore, they were intensively investigated as restorative materials of choice for deciduous teeth. However, most of these trials have been conducted on the

* B.D.S (2009), Faculty of Dental Medicine, Boys, Assuit, Al-Azhar University.
** Associate Professor, Head of Pedodontics and Oral Health Department, Faculty of Dental Medicine, Boys, Cairo, AL-Azhar University
*** Lecturer of Pedodontics and Oral Health, Faculty of Dental Medicine, Boys, Cairo, Al Azhar University.
**** Associate Professor of Dental Bio-materials, Faculty of Dental Medicine, Boys, Cairo, Al Azhar University
• ***Corresponding author*:** dentistmohamedsaber@gmail.com

DOI: *10.21608/ajdsm.2021.34151.1073*

quintessential glass-ionomer and not so much on its modifications [3].

The last decade has seen several innovative additions to enhance the properties of GIC whilst simplifying its usage. Unlike the early glass-ionomers, these newer systems are easy and more practical to use as a dental restorative and luting material for preschoolers, children and teenagers alike [4].

These newer glass-ionomers also claim to address the poor physical properties such as surface crazing and low fracture resistance which had negatively affected its' clinical usage for long [5,6].

Zirconia infused GIC (zirconomer) is one such recent addition to the GIC family which has been introduced to address all the issues that have plagued the conventional glass-ionomer thus far, however, this newer cement zirconomer has not been challenged clinically and there is only laboratory-based evidence of it is having better mechanical properties and superior esthetics [7]. Also it has also been claimed to have a shear bond strength equivalent to amalgam and a fluoride releasing capacity similar to conventional GIC. Hence, we ventured with an objective to compare the clinical performance and color stability of ZrO_2 infused GIC with conventional GIC so as to put these claims to test.

MATERIALS AND METHODS

Study design

- It is Intervention randomized clinical trial study.

Study setting and population

- Eighteen molars of 9 children with dental caries without pulp involvement in class II primary molar teeth.
- Patient selected from Outpatient Clinic of the Department of Pedodontics and Oral Health, Faculty of Dental Medicine, Al-Azhar University.
- Age from 4 -8 years old

Sample size

A sample size of 9 in each group has 80% of power to detect a difference between means of 4.17 with a significance level (alpha) of 0.05 (two-tailed). In 80% (the power) of those experiments, the P value will be less than 0.05 (two-tailed) so the results was deemed "statistically significant". In the remaining 20% of the experiments, the difference between means was deemed "not statistically significant". Report created by GraphPad Stat Mate 2.00.

I- In vivo study:

In this study, 18 posterior primary molars in 9 children by using split mouth technique were classified equally in to two groups.

Group 1:- 9 deciduous molars were restored with resin-modified glass ionomer filling.

Group 2:- 9 deciduous molars were restored with zirconia infused glass ionomer filling.

Follow up using the FDI criteria to evaluate the clinical performance of both materials.

II- vitro study:

18 freshly extracted human deciduous molars with no crack, decay or structure deformities were collected and stored in normal saline.

Group 3:- 9 extracted deciduous molars were restored with resin-modified glass ionomer filling.

Group 4:- 9 extracted deciduous molars were restored with zirconia- infused glass ionomer filling.

1- Shear bond strength calculation:

A circular interface shear test was designed to evaluate the bond strength.

All samples were individually and horizontally mounted on a computer-controlled material testing machines to calculate shear bond strength.

2- Wear resistance calculation:

The two-body wear testing was performed using a programmable logic-controlled equipment (Four stations multimodal ROBOTA chewing simulator) Integrated with thermo-cyclic protocol operated on servo-motor.

Both groups samples (Zirconomer and Riva and their corresponding teeth specimens) were mounted and tested sequentially under the **50 N** loads for a number of 37500 cycles under the wear testing parameters.

Eligibility criteria of population

- Inclusion criteria

  i. Children having carious primary molars indicated for restoration

  ii. Patients should be healthy with no systemic disease.

  iii. Children with a behavior rating of 3 or 4 on the Frankl (Frankl 3: The child is cooperative, but somewhat reluctant/shy. Frankl 4: The child is completely cooperative and enjoys the experience). [142]

- Exclusion criteria

  i. Patients with systemic diseases or bleeding disorders.

  ii. Exposed pulp

  iii. Patient with parafunction habits like bruxism was not included in this study, because bruxism plays an important role in fatigue development in the tooth-restoration complex.[143]

Intervention

Initially, the cavity was prepared with minimal invasive technique Class II resin composite restorations not extend beyond the proximal line angles. Bassler bur no 330 is used. A wedge and universal matrix system were placed interproximal. Restorative materials were applied according to the manufacturer's directions. Following removal of the matrix band, diamond finishing burs, yellow rubber cups and aluminum oxide discs were used for finishing and polishing of the restorations. Figure (1).

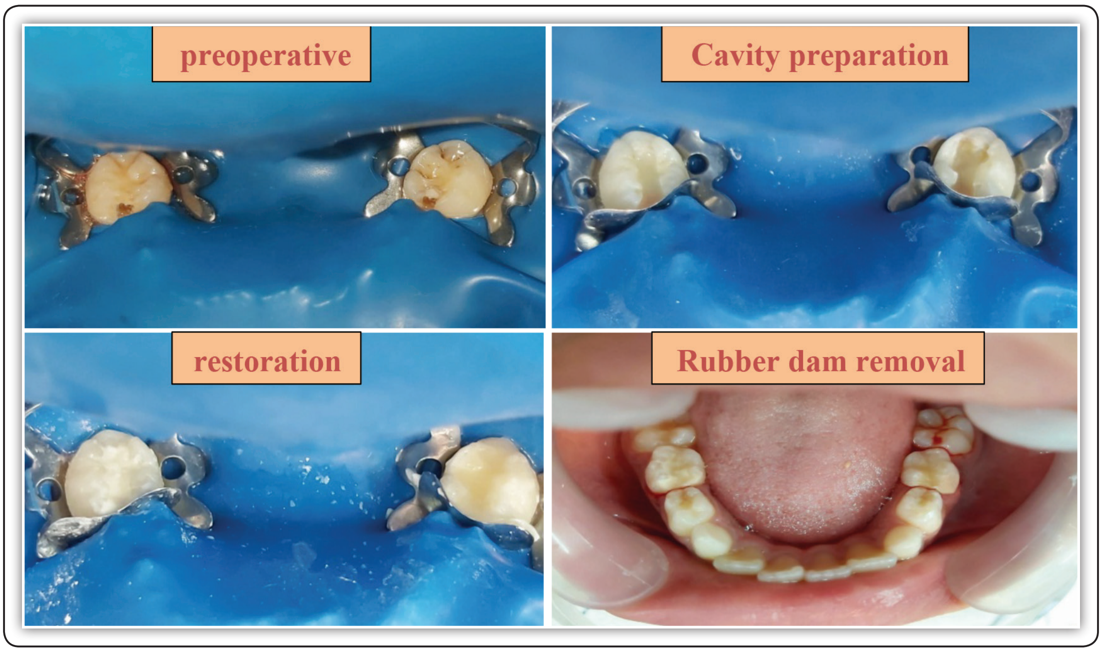

FIG (1) Showed (A, B) class II at lower second right and left primary molars restored with RMGI and Zirconomer(split mouth technique).

Ethical consideration

The study was approved by the pedodontics scientific Committee and department council, Faculty of Dental Medicine, Boys, Cairo, Al-Azhar University. A signed informed consent was done from the parents of each child prior to beginning the study

Statistical Analysis:

Data were represented by mean, standard deviation (SD), median (M), with 95% Confidence Interval (95% CI) values. Repeated measures ANOVA test and descriptive statistics were used to compare between different designs and surface treatments. The significance level was set to P ≤ 0,05. Statistical analysis was performed with IBM®* SPSS®ϴ Statistics Version 20 at 95% confidence interval.

RESULTS

The present study included two parts in vitro and in vivo parts. In vitro part, the study will be to evaluate the shear bond strength and wear resistance for two materials Zirconomer and Riva while in vivo part for measuring clinical criteria as approved by the FDI esthetic parameters, functional parameters and biological parameters. Eighteen Egyptian child patients suffering from dental caries in molar teeth Patient will be selected from Outpatient Clinic of the Department of Pedodontics and Oral Health, Faculty of Dental Medicine, Al-Azhar University and classified into two sub groups according to material used.

Data were represented by mean, standard deviation (SD), with 95% Confidence Interval (95% CI) values. Repeated measures ANOVA test and descriptive statistics were used to compare between different designs and surface treatments. The significance level was set to P ≤ 0,05. At 95% confidence interval.

In vitro part

- **Wear:** A total number of 18 samples were used in this study. The samples were divided into 2 main groups according to type of materials (each group was 9 samples). There was no statistically significant difference between Riva and Zirconomer for amount of wear regardless of surface wear (disc or teeth) as p = 0.45; (Table 1)
- **Bond strength:** 18 freshly extracted human deciduous mandibular molars with no crack, decay or structure deformities were collected and stored in normal saline after removing tissue tags the teeth were cleaned with pumice.

Shear bond strength calculation;

The load at failure was divided by bonding area to express the bond strength in MPa:

$\tau = P/ \pi r^2$

Where; τ =shear bond strength (MPa, P =load at failure (N), π =3.14 and

r =radius of disc (mm)

There was highly statistically significant difference between Riva and Zirconomer as p = 0.0004. Bond strength is higher with Riva than Zirconomer.

TABLE (1) Comparison between amount of wear and shear bond strength of Riva and Zirconomer regardless of surface used (disc or teeth)

		Mean	SD	P
Wear resistance	Riva	0.004	0.0037	0.45
	Zirconomer	0.006	.0037	
Shear bond strength	Riva	5.018	2.268	0.0004
	Zirconomer	11.810	1.265	

In vivo part

Comparison between evaluation criteria (percentage) for Riva and Zirconomer

The study will be to evaluate the esthetic evaluation (FDI evaluation). Clinical criteria were approved by the FDI World Dental Federation since 2007, these criteria were categorized into three groups: esthetic parameters (four criteria), functional parameters (six criteria) and biological parameters (six criteria). Each criterion can be expressed with five scores, three for acceptable and two for non-acceptable (one for reparable and one for replacement). The criteria have been used since 2007. Eighteen Egyptian child patients suffering from dental caries in molar teeth. Patients will be classified into the following groups Group 1: comprises 9 primary molar received zirconia reinforced glass ionomer (zirconomer Improved) and Group 2: comprises 9 primary molar received resin modified glass ionomer (RIVA); (Table 1 & Fig. 2)

TABLE (2) Comparison between evaluation criteria (percentage) for Riva and Zirconomer

	Aesthetic		Biologic		Functional	
	Riva	Zir	Riva	Zir	Riva	Zir
1. Clinically excellent	0.00	0.00	0.00	0.00	0.00	0.00
2. Clinically good	11.11	22.22	22.22	22.22	55.56	33.33
3. Clinically sufficient	77.78	55.56	66.67	55.56	33.33	44.44
4. Clinically unsatisfactory	0.00	0.00	0.00	0.00	0.00	0.00
5. Clinically poor	11.11	22.22	11.11	22.22	11.11	22.22

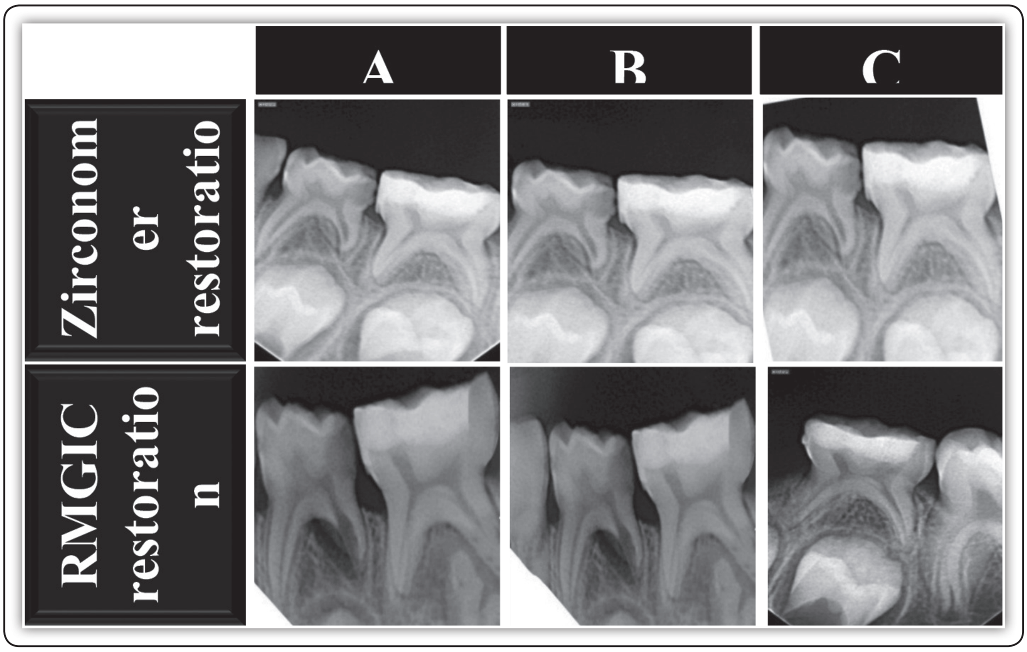

FIG (2) Showed (A (immediate), B (after 3 months),C (after 6 months)) class II at lower second right and left primary molars restored with RMGI and Zirconomer(split mouth technique).

DISCUSSION

The result of this study revealed that the resin modified glass ionomer recorded statistically the higher shear bond strength and lower value of test are zirconia reinforced glass ionomer. This result is agreement with some investigators who compared shear bond strength of two commercially available resin-modified glass ionomer cements to bovine dentine, The explanations for this include the possibility of the formation of a hybrid like layer and the development of the better wetting of the dentin by the HEMA contained in the RM-GIC [8].

The result of this study concluded that the better clinical performance of resin modified glass ionomer cement could be due to their expected dual mechanism of adhesion [9]. For conventional glass ionomer the underlying mechanism of adhesion is thought to be based on a dynamic ion exchange process, in which the polyalkenonic acid softens and infiltrates the hydroxyapatite structure. There it is hypothesized to displace calcium and phosphate ions out of the substrate and to form an intermediate adsorption layer of calcium and aluminum phosphates and polyacrylates at the glass ionomer hydroxyapatite interface. In case of resin modified glass ionomer cement the adhesion is probably through a combination of later mechanism and micro mechanical bonding mechanism [10].

Other investigations reported that the lower shear bond strength of zirconia reinforced glass ionomer might be due to presence of fewer amounts of free carboxylic groups that can chemically bond with dentine. The adhesion between glass ionomer filling material and tooth structure depend on formation of hydrogen bonds originating from the free carboxyl groups in the cement interacting with tightly bound water on the surface of the mineral phase of the tooth. These hydrogen bonds seem to be gradually replaced by true ionic bonds formed from cations in the tooth interacting with polymeric anions in the cement. This finding is in agreement with some studies that showed that an ion-exchange layer was slowly formed between the tooth and the restoration [11-13].

In the present study the resin-modified glass ionomer was used due to good bonding by resin-modified glass-ionomers is partly a function of the fact that they contain a polymeric acid such as poly(acrylic acid), which is capable of interacting strongly with the mineral phase of the tooth [14]. In addition, they contain HEMA, a substance that is also currently used as a component of dentine bonding agents [15].

In the present study the effect of this combination is not known for certain, but is likely to result in high bond strengths and durable bonding to the tooth surface. Unlike conventional glass-ionomers, there is evidence that resin-modified glass-ionomers bond more strongly to the dentine than to the enamel, and this may be a function of their HEMA content [16].

In the present study the bonding of resin-modified glass-ionomer is associated with the formation of a gel phase at the interface between the material and the tooth surface. This phase seems to originate from the acid–base part of the formulation, as it consists substantially of calcium polyacrylate, a substance that forms as the cement sets. However, the gel phase is more substantial in these materials than in conventional glass-ionomers, so that its occurrence owes something to the overall composition of resin-modified glass-ionomers [17].

In the present study the wear of a material which takes place in the mouth has traditionally been divided into wear at contact free areas and wear caused by antagonists at occlusal contact areas, and a reliable wear machine must be able to reproduce these two modes of wear. Pallav et al [18]. have suggested that wear as it occurs on occlusal surfaces may be composed of three components: firstly, erosive activity at a contact free areas and occlusal contact areas; secondly, ‘pin-on-disk’ phenomena from detached filler particles on a microscale at occlusal contact areas; and thirdly, surface fatigue. It is not clear which mechanisms are most important for the different categories of materials, and it has not been determined which properties of a material lead to good wear resistance.

In the present study we revealed that there was no difference between Riva and Zirconomer for amount of wear resistance. This is agreement with some investigators who compared wear resistance of two commercially available resin-modified glass ionomer filling materials [19].

This is disagreement with some investigators who compared wear resistance of two commercially available resin-modified glass ionomer filling materials compared to zirconomer. This is due to Zirconomer is a ceramic and zirconia reinforced glass ionomer cement. It exhibits the strength of amalgam and at the same time maintain the fluoride releasing capacity of GICs [20]. RMGI is the latest addition to the glass ionomers that offer unsurpassed wear resistance, compressive strength, and durability. This product contains glass filler, Smart Glass. Addition of this filler provides higher translucency, reactivity and a faster setting time [21].

CONCLUSION

From the results of the present study we can conclude:

1. RMGI show better shear bond strength than zirconomer.
2. There is no significant difference between RMGI and zirconomer in wear resistance.
3. Clinical performance of RMGI is better than zirconomer.

REFERENCES

1. Sikri K. Color Implications in dentistry. J Conserv Dent 2010; 13:249-55.
2. Wilson D and Kent E. A new translucent cement for dentistry. The glass ionomer cement. Br Dent J 1972; 132:133-5.
3. Tyas J. Clinical performance of glass ionomer cements. J Minim Interv Dent 2008; 1:88-94
4. Croll P and Nicholson W. Glass ionomer cements in pediatric dentistry: Review of the literature. Pediatr Dent 2002; 24:423-9.
5. Yadav G, Rehani U and Rana V. A comparative evaluation of marginal leakage of different restorative materials in deciduous molars: An in vitro study. Int J ClinPediatr Dent 2012; 5:101-7.
6. Cho Y and Cheng C. A review of glass ionomer restorations in the primary dentition. J Can Dent Assoc 1999; 65:491-5.
7. Gu W, Yap U, Cheang P and Khor A. Zirconia – Glass ionomer cement – A potential substitute for miracle mix. Scr Mater 2
8. ARORA and Varun, et al. Comparison of the shear bond strength of RMGIC to a resin composite using different adhesive systems: An in vitro study. Journal of conservative dentistry: JCD, 2010, 13.2: 80.
9. FRANCO and Eduardo Batista. 5-year clinical performance of resin composite versus resin modified glass ionomer restorative system in non-carious cervical lesions. Operative Dentistry, 2006, 31.4: 403-408.
10. Prabhakar, A. R., et al. Comparison of shear bond strength of composite, compomer and resin modified glass ionomer in primary and permanent teeth: an in vitro study. journal-Indian society of pedodontics and preventive dentistry. 2003, 21.3: 86.
11. A Ezz, Ahmed, et al. Bonding ability and mechanical strength of recently formulated glass ionomer cements. Al-Azhar Journal of Dental Science. 2018, 21.2: 147-154.
12. Perdigao, Jorge, Swift EJ and Walter. Fundamental concepts of enamel and dentin adhesion. Sturdevant's Art and Science of Operative Dentistry. 2014, 114-140.
13. Abdulsamee, Nagy, Elkhadem and Hosny A. Zirconomer and Zirconomer Improved (White Amalgams): Restorative Materi-als for the Future. Review. EC Dental Science. 2017, 15: 134-150.
14. Nicholson and John W. Adhesion of glass-ionomer cements to teeth: a review. International Journal of Adhesion and Adhesives. 2016, 69: 33-38.
15. Çetingüç, Ayşegül; Ölmez and Seval. HEMA diffusion from dentin bonding agents in young and old primary molars in vitro. Dental Materials. 2007, 23.3: 302-307.
16. Amer RS and Kolker JL. Restoration of root surface caries in vulnerable elderly patients: a review of the literature. Special Care in Dentistry. 2013, 33.3: 141-149.
17. Mitra and Sumita B., et al. Long-term adhesion and mechanism of bonding of a paste-liquid resin-modified glass-ionomer. Dental Materials. 2009, 25.4: 459-466.
18. Sun KK, Naty K, Seong JH and Chang IT. study and effect of chewing patterns on occlusal wear. Journal of Oral Rehabilitation. 2018(11):1048-55.
19. Lewis R and Dwyer JR. wear of human teeth: tripological perspective. ARCHIVE Proceedings of the Institution of Mechanical Engineers Part J Journal of Engineering Tribology. 1996; 19(1):2-19.
20. Abdulsamee N and Elkhadem AH. "Zirconomer and Zirconomer Improved (White Amalgams): Restorative Materials for the Future. Review". EC Dental Science 2017:134-50.
21. Khoroushi M and Keshani F. A review of glass-ionomers: From conventional glass-ionomer to bioactive glass-ionomer. Dent Res J (Isfahan). 2013; 10(4): 411– 20.