ORIGINAL RESEARCH

Evaluation of Fluoride Related Traits of Zirconia Infused GIC

A. R. Prabhakar[1], Kalimireddy. L. Priyanka[2], Sugandhan. S[3], Saraswathi V. Naik[4]

1-MDS, Department of Pediatric Dentistry, Bapuji Dental College and Hospital, Davangere-577004, Karnataka,India.,2-Postgraduate Student (Persuing MDS) Department of Pediatric Dentistry, Bapuji Dental College and Hospital, Davangere-577004, Karnataka, India.

Correspondence to:
Dr. Kalimireddy. L. Priyanka, Post graduate student, Dept. of Pedodontics and Preventive Dentistry, Bapuji Dental College & Hospital, Davangere-577004. Karnataka, India
Contact Us: www.ijohmr.com

ABSTRACT

Objectives: - To compare and evaluate the fluoride releasing property, remineralization potential and antibacterial property of Zirconia infused GIC with Conventional GIC. **Methods: -** (1) Fluoride release – 11 cement specimens of each group were analysed for fluoride release values at the end of 24 hours, 7 days and 28 days using specific electrode ion analyzer; (2) Remineralization potential – 17 human premolars were used to analyse the remineralization potential of the two cements following a cycle of demineralization for 2 days and then remineralization phase for 28 days; (3) Antimicrobial property – 11 cement specimens of each group were placed in mitis salivarius bacitracin agar plates which were later assessed by using Vernier Caliper to measure the diameter of zones of bacterial inhibition. **Results:** Zirconia-reinforced GIC was overpowered by Conventional type II GIC (Group I) as it was found to have better fluoride releasing property. **Significance: -** Adding Zirconia to reinforce GIC reduced the fluoride release, remineralization potential and antibacterial property of Glass Ionomer system.

KEYWORDS: Conventional GIC, GLASS ionomer cement, Zirconia, Fluoride

INTRODUCTION

The discovery of Glass ionomer cement by Wilson and Kent has opened a new realm of possibilities in the world of dentistry. This led to the paradigm shift of restorative dentistry from G.V. Black's invasive "extension for prevention" approach to a "minimally invasive" slant with advanced diagnostic systems and uprising adhesion technology.[1,2]

Currently, there is an endless fervour for advanced materials and techniques in dentistry due to changing professional perceptions and to meet the patient's demands for higher aesthetic and biocompatible restoration at lower costs.[3]

Way back in the 1960s there was an availability of a variety of restorative materials including amalgam, composite, cast alloys, etc., but none of them could be categorized under ideal restorative materials. An ideal restorative material is the one that is aesthetic, biocompatible, adhesive, anticariogenic and relatively economical.[4] Researchers then began their quest for a new material that would not only act as a restorative but also replace enamel and dentin.[5] This led to the invention of Glass ionomer cement (GIC) in 1969 and the material came to light in the1970s after being reported by Wilson and Kent.[6]

Since then, the Glass ionomer cement has been a time-honoured restorative material which has been tried and tested with various modifications. And now that we have reached an era of aestheticism, the strongest dental material with best aesthetics i.e. Zirconia was also not spared from being added to the trail of modifications of GIC.

Although the ultimate evidence of clinical performance of any restoration is provided by clinical trials, a preparatory groundwork on the properties and assurance of the material through in vitro experimentation is mandatory.[7] And hence, few studies have been conducted on this alteration of adding Zirconia to GIC. But, they did not cover the major facets of GIC like fluoride-releasing properties, remineralization potential, and antibacterial property, which pretty much justifies the intention behind the present study.

The current paper will enlighten the effect of fluoride releasing property of Zirconia-reinforced GIC on remineralization and the antimicrobial activity of the cement.

MATERIALS AND METHOD

Ethical clearance for this study was obtained from the Institutional review board of Bapuji Dental College and Hospital, Davangere. This was an experimental, in vitro inter-group study between two materials including –

- Group I (Control): Conventional Type II Glass ionomer cement (SHOFUINC. Kyoto, JAPAN).
- Group II (Experimental): Zirconia-reinforced glass ionomer (ZIRCONOMER SHOFUINC. Kyoto, JAPAN)

The study has been conducted under 3 parameters which include Fluoride releasing property, Remineralization potential and Antimicrobial property.

How to cite this article:
Prabhakar AR, Kalimireddy L P, Sugandhan. S, Saraswathi V N. Evaluation of Fluoride Related Traits of Zirconia Infused GIC. Int J Oral Health Med Res 2016;2(6): 17-20.

Fluoride releasing property: 11 cement specimens of standard dimensions were made of each group using brass mould after which the specimens were placed in deionized water until the time of measurement. Each prepared sample was stored in an individual tightly sealed plastic container with 20 ml deionized water at a constant temperature of 37 ± 0.5°C until the time of measurement (Fig 1 a& b). 5 ml of deionized water was extracted from each container and analysed for fluoride release after 1:1 dilution with TISAB (Total Ionic Strength Adjustment Buffer) using fluoride ion selective electrode connected to an Orion 940 Ion analyser (Fig 2). Fluoride release was analysed at 3 intervals which are at 24 hours, after 7 days and 28 days.[8]

Fig 1 (a): Group I cement specimen; (b) Group II cement specimen

Fig 2: Specific Ion Electrode for fluoride release estimation

Remineralization potential: The remineralization potential was evaluated followed by the initial demineralization cycle of immersing all 17 human premolar specimens in artificial caries solution containing 2.2 mM of Ca^{+2}, 2.2 mM of PO_4^{-3} and 50 mM of acetic acid at a pH of 4.4 for 2 days, after which 33 sections were obtained by hemisectioning and distributed into 3 groups of 11 samples each where in one group had the control specimens with artificial caries which were sectioned to 100 microns and viewed under polarized light microscope to analyse the demineralized areas. The rest of the 22 samples were randomly divided into two groups for restoration with two different materials which were then individually immersed in artificial saliva for 30 days. Artificial saliva was changed every 2 days. At the end of 30 days, 100 micron sections of the restored tooth samples were photomicrographed under polarized light microscope to evaluate the remineralization areas (Fig 3 a & b).[9-10]

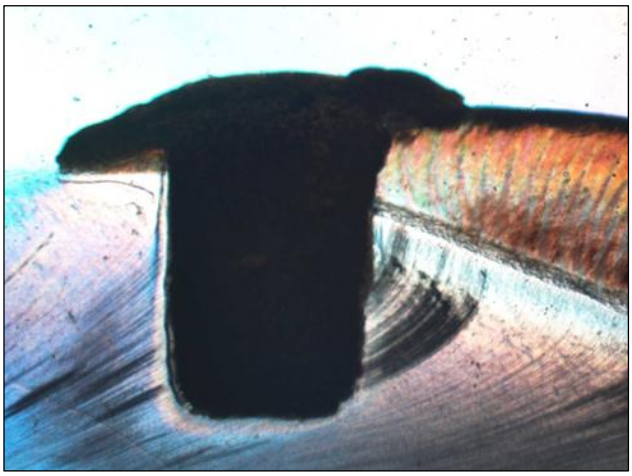

Fig 3a: 100 µm section showing remineralized areas in Group I specimen under polarized light

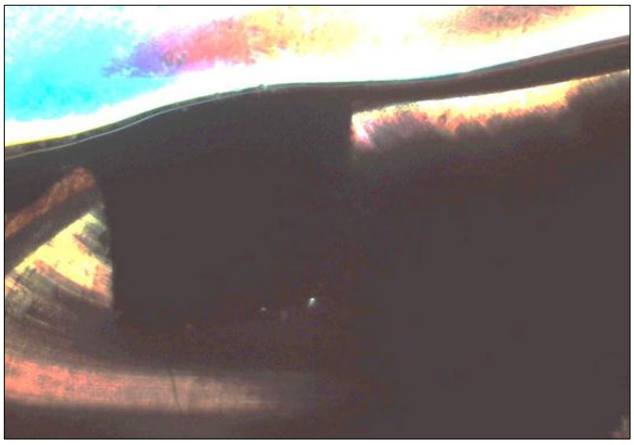

Fig 3b: 100 µm section of Group II specimen under polarized light

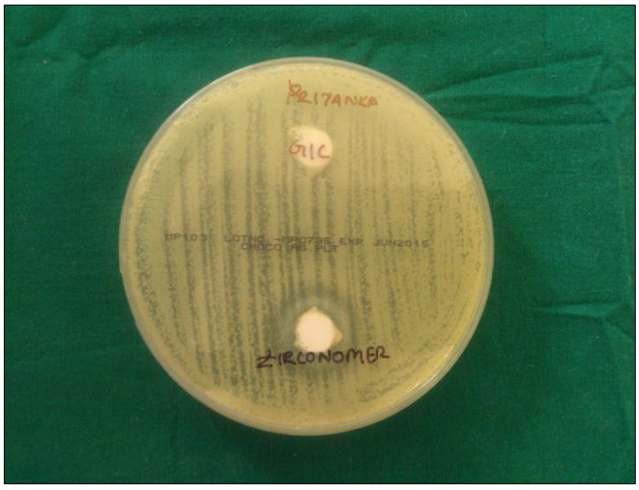

Fig 4: Agar plate with Group I and Group II specimens

Antimicrobial property: This was evaluated by isolating Streptococcus mutans in the strains of mitis salivarius bacitracin agar. Strains were grown in the brain heart infusion broth incubated anaerobically for 24 hours at 37^0C. Strains were grown and sub cultured in mitis

salivarius agar. Two wells were prepared using a standard bore with a diameter of 5 mm on agar plate. 11 specimens of each material were prepared according to manufacturer's instructions and were placed in the mitis salivarius bacitracin agar plates. The agar plate was further incubated anaerobically for 48 hours at 37^0C. Antimicrobial property of the materials was assessed from the diameter of the circular zones of bacterial inhibition which was measured using Vernier caliper (Fig 4).[11]

RESULTS

The fluoride release results were subjected to Independent sample't' test and repeated measures ANOVA test (Table 1), the remineralization potential values were analyzed by ANOVA test (Table 2) and antimicrobial property was assessed by Mann-Whitney U test (Table 3).

Group	Fluoride release	Mean (SD)	Repeated measures ANOVA	
			F- statistic(df)	P-value
GROUP I	24 hrs	0.22 (±0.05)	60.79(2)	<0.001*
	7 days	0.22 (±0.05)		
	28 days	0.05 (±0.01)		
GROUP II	24 hrs	0.11 (±0.02)	25.28(1.21)**	<0.001*
	7 days	0.21 (±0.07)		
	28 days	0.04 (±0.01)		

Repeated measures ANOVA*, Statistically significant*

Table 1: Descriptive statistics of the inter group comparison of the mean and standard deviation of fluoride release values of Group I & Group II after 24 hours, 7 days & 28 days with repeated measures ANOVA test.

GROUPS	N	Mean (SD)	F	P-value
Control	11	-8.84 (±3.03)	53.405	<0.001*
GROUP I	11	10.40 (±5.33)		
GROUP II	11	5.90 (±4.99)		

ANOVA *p<0.05 statistically significant

Table 2: Descriptive statistics of the inter group comparison of the mean and standard deviation of remineralization potential values of Group I & Group II with ANOVA test.

Parameters	Anti-microbial property	
	Group 1	Group 2
N	11	11
Mean (SD)	Resistant	23.73(±2.61)
Median	Resistant	25(20-25)

Mann whitney U test

Table 3: Descriptive statistics of the inter group comparison of the mean and median of the antibacterial property values of Group I and Group II.

Zirconia-reinforced GIC was overpowered by Conventional type II GIC (Group I) as it was found to have better fluoride releasing property which eventually lead to better remineralization potential and antibacterial property.

DISCUSSION

YW Gu et al have tested the strength of glass ionomer cement when infused with Zirconia and found it to be superior compared to conventional GIC.[12] But, the exclusive fluoride releasing feature of GIC has not been put to trial when GIC is reinforced with Zirconia. There is absolutely no evidence on the fluoride releasing characteristics of Zirconia infused GIC which has been the prime focus in the current study.

Bertolini et al. had noticed that the greatest release of Fluoride from GIC occurred on the first day and diminished gradually.[8] But, the Zirconia-reinforced samples took an interesting turn from a low fluoride release value after 24 hours to an increased value after 7 days which again degraded after 28 days. At the end of 28 days, there was not a significant difference between the Fluoride release values of Group I and Group II samples (Fig 5).

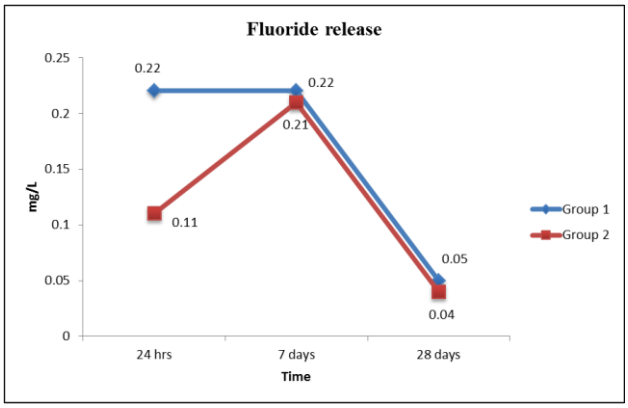

Fig 5: Represents the mean fluoride release between Group I and Group II at 24 hours, after 7 days and 28 days.

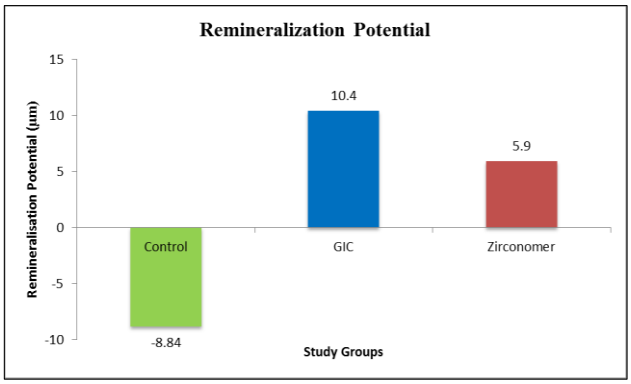

Fig 6: Represents the remineralization potential between Group I and Group II

With respect to remineralization potential, the evaluation becomes irrelevant if the demineralization phase is absent.[9] Ten Cate observed the need for the presence of partially demineralized crystallites to act as a clean surface for mineral deposition for remineralization to occur.[13] Kofman et al noted that fluoride released from a GIC had the potential to enhance remineralization of the early carious lesion in vitro.[14] A similar scenario was observed in this study where in the control group samples containing conventional glass ionomer cement restorations showed an increased remineralization potential when compared to the experimental group containing Zirconia-reinforced GIC restoration. This is probably due to the increased fluoride release observed in

conventional GI samples which led to increased remineralization of artificially created carious lesions (Fig 6).

Fluoride releasing property was directly associated with the antibacterial activity of GIC.[15] Marsh et al. reported that Fluoride inhibited the growth of mutans streptococci.[16] A high fluoride concentration in the oral cavity might inhibit acid production by bacteria and may reduce the numbers of certain species of bacteria.[17] From the above findings it can be concluded that as the Group I samples had an increased fluoride release value after 24 hours compared to Group II samples they eventually showed the same result with respect to antibacterial property where in all the Group I samples were resistant to Streptococcus mutans and all the Group II samples showed circular zones of bacterial inhibition with diameter ranging from 20-28 mm.

CONCLUSION

Within the limitations of this study, the following conclusions were drawn: -

- Zirconia reduced the fluoride releasing capacity of the glass ionomer cement.
- Reinforcing GIC with Zirconia reduced the remineralization potential of GICs.
- Zirconia infused GIC was not resistant to Streptococcus mutans.

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Source of Support: Nil
Conflict of Interest: Nil