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AN INVITRO EVALUATION OF FLUORIDE RELEASE FROM THREE DIFFERENT TYPES OF GLASS IONOMER CEMENT

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ABSTRACT

Background: The antibacterial effect and cariostatic properties of glass –ionomer cement are associated with the amount of fluoride released ,therefore the aim of the study was to evaluate fluoride release from three different glass ionomer cement (GIC)-based restorative materials .

Materials and methods :a total of 42 samples of extracted caries free permanent molars were obtained as 14 samples in each group .group A(FujiIX:resin modified glass ionomer cement),group B (Voco:TGIC) and group C (Ketac Molar) each tooth was prepared for conventional class I cavity preparation , followed by application of the restorative material then kept in artificial saliva to be examined for fluoride release after 48hours,7,15,28 days using Orion fluoride electrode.

Results: according to this study ,there is different in fluoride release between the study groups according to the time interval ,where group A showed the statistically significant value in relation to group B&C($P<0.005$).

Conclusions :this study showed that FujiIX was the material of the highest fluoride release value.

KEY WORD : fluoride release, glass ionomer cement, fujiix, vovo, ketac molar .

INTRODUCTION

The modern quality Dentistry requires the dentist to adopt different treatment decision making substituting preventive strategies for unnecessary invasive procedures with the help of newly developed dental materials [1].

For caries prevention, the preventive effect of fluoride has been established by the ability of fluoride to remineralize porous enamel and softened dentine, moreover to provide a low and effective quantity of fluoride over a period of time, this require a slow rechargeable fluoride release system from dental materials [2-4].

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Fluoride basic effect for strengthening dental structure is provided by the transformation of hydroxyapatite crystals to flouroapatite crystals that are more resistance to acid, beside the effect of fluoride as a bactericidal and bacteriostatic agent on glucose transportation systems of microorganisms and carbohydrate metabolisms [5, 6].

Evidence from previous studies showed that ,conventional glass ionomer cements (GIC) and resin modified glass ionomer (RMGI) are still considered the exclusive materials with higher fluoride release ability and could clinically specified to repair decayed non pitted areas in high risk patients[7, 8].

The aim of the study was to evaluate fluoride release from three different glass iomomer cement (GIC)-based restorative materials.

MATERIALS AND METHODS

This study was performed on newly extracted permanent molars without cavities, cracks voids completely sound. Collected from oral and maxillofacial surgery clinic in faculty of dentistry Cairo University and, surgery clinic of National diabetes and endocrinology institute Cairo University, were teeth were extracted due to periodontal affection for first and second molars or partially impacted third molars.

Sample size calculation:

A power analysis was designed to have adequate power to apply a statistical test of the null hypothesis that there is no difference would be found between tested groups. By adopting an alpha (α) level of (0.05), a beta (β) of (0.2) (i.e. power=80%), and an effect size (f) of (0.568) calculated based on the results of a previous study[9]. The minimum required sample size (n) was found to be (33) samples (i.e. 11 samples per group). Sample size calculation was performed using G*Power version 3.1.9.7 [10].

Based on this calculation this study was performed on 42 extracted permanent molars, divided into three equal groups (14 tooth per group).

Specimen preparation

Remnants tissues were removed from the extracted teeth using curette under running water then stored in 0.9% saline at room temperature till use in study for about two weeks. Occlusal cavity preparation were made for all teeth with the aid of periodontal probe to nearly adjusted with the following dimensions , mesiodistal width 2mm, buccolingual width 2mm, and occluso-pulpal depth 1.5mm, using a diamond fissure bur under water cooling by a single researcher. The depth and width of the cavities were checked and standardization was confirmed using a graduated periodontal probe [11]. The teeth were then randomly divided into three groups;

Group A (FujiIX:resin modified glass ionomer cement)

Cavities were washed with water then were gently dried using cotton pellet and air . RMGIC(FujiIX,GC Dental,Tokyo,Japan)* capsule was first shaken and the button was completely pushed then mixed for 10 s in an amalgamator. Applicator gun was then used to inject the material into the cavity. Setting time was 6 min according to the manufacture instruction after which finishing the restoration was performed.

Group B (Voco: traditional glass ionomer cement)

After washing and drying the cavities, a metal spatula was used to mix a powder measure from the TGIC (Ionofil,voco,GmbH,Germany)** with 1 drop of the liquid. Mixing time was 50-60s according to the manufacture instructions. Polymerization process was 4-5mins. After which, finishing the restoration was performed**.

Group C (Ketac Molar.TGIC)

Washing and drying the cavities were performed as mentioned in the previous groups. . TGIC (Ketac Molar Easymix 3M ESPE,Germany)*** was mixed in the following ratio: 1 spoonful of powder to 1 drop of liquid. Mixing time was less than 30s according to manufacture instruction then the mix was applied to the cavity in layers. Polymerization time was 5 min followed by finishing the restoration with fine grain diamond stone*** . All of the materials were kept in moist environment at 95% relative humidity and 37°C for 24 hours to allow them to set completely. Then transferred to the department of biochemistry faculty of medicine Cairo University.

Fluoride release measurement:

Teeth were stored in artificial saliva for 24 hours in the biochemistry lab. Measuring date starting from second day (after 48 hours) then after 7 days then after 15 days then after 28 days.

Fluoride release was measured by Fluoride electrode coupled with standard pH meter using Orion 901 microprocessor ion analyzer & Orion 407 (Sigma-Aldrich, Germany) [9]. . The readings observed are the electrode potentials of the standard / sample solutions from which fluoride concentration is calculated. Unknown concentration of fluoride in the sample can be calculated by typical calibration curve. By applying electrode potential difference equation. Direct ppm reading [12] was taken and the value shown on the screen was recorded. At each point of time, 3 measurements were taken from each sample and the average of the 3 measurements was used for the analysis. Before and after each measurement, the electrode tip was washed in distilled water and lightly dried to remove any remaining fluoride ions.

Statistical analysis

Numerical data were presented as mean and standard deviation (SD) values. Shapiro-Wilk's test was used to test for normality. Homogeneity of variances was tested using Levene's test. Data were parametric and showed variance homogeneity so one-way ANOVA test followed by Tukey's post hoc test was used to analyze intergroup comparisons. The significance level was set at p<0.05 within all tests. Statistical analysis was performed with R statistical analysis software version 4.1.2 for Windows [13].

RESULTS

Results of intergroup comparisons of fluoride release presented in table (1) and in figure (1) showed that at all intervals, there was a significant difference between fluoride release values in different groups with group (A) having a significantly higher value than other groups (p<0.001).

Results of intragroup comparisons of fluoride release presented in table (1) and in figure (2) showed that there was a significant difference between values measured at different intervals in all groups (p<0.001). For group (A), the highest value was recorded after 2 days, followed by a significant decrease at 7 and 14 days, then a significant increase after 28 days (p<0.001). For group (B), there was an insignificant increase of fluoride release from 2 days until 14 days, then there was a significant decrease after 28 days (p<0.001). For group (C), the highest value of release was found after 2 days, followed by significant decrease at 7 and 14 days, then a further significant decrease at 28 days (p<0.001).

Results of intergroup comparisons of fluoride release percentage change (%) presented in table (2) and in figure (3) showed that at all intervals except for (7-14 days), there was a significant difference between different groups (p<0.001). For (2-7 days) difference, there was an increase in release in group (B), while in groups (A) and (C) there was a decrease with all pairwise comparisons being statistically significant (p<0.001). For (7-14 days) difference, there was an increase of release in group (B), and a decrease in groups (A) and (C) with no significant difference between groups (p=0.129). For (14-28 days) difference, there was an increase of release in group (A) and a decrease in groups (B) and (C), with group (A) having a significantly higher value than other groups (p<0.001). For (2-28 days) difference, there was a decrease in release in all groups, with the highest change found in group (C), followed by group (B) and the least change found in group (A) and all pairwise comparisons were statistically significant (p<0.001).

TABLE (1): Inter and intragroup comparisons of fluoride release (μgF/cm2)

Interval	*Fluoride release (μgF/cm2) (Mean±SD)*			*p-value*
	Group (A)	*Group (B)*	*Group (C)*	
2 Days	78.71±21.15[Aa]	36.50±10.92[Ba]	40.78±9.00[Ba]	**<0.001***
7 days	68.96±18.99[Ac]	37.16±12.17[Ba]	31.86±5.99[Bb]	**<0.001***
14 days	67.95±18.19[Ac]	37.88±12.02[Ba]	30.79±5.98[Bb]	**<0.001***
28 days	74.99±20.35[Ab]	30.22±9.58[Bb]	26.03±5.18[Bc]	**<0.001***
p-value	**<0.001***	**<0.001***	**<0.001***	

Different upper and lowercase superscript letters indicate a statistically significant difference within the same horizontal row and vertical column respectively; *significant (p<0.05)

TABLE (2): Inter and intragroup comparisons of fluoride release percentage change (%)

Interval	*Fluoride release percentage change (%) (Mean±SD)*			*p-value*
	Group (A)	*Group (B)*	*Group (C)*	
2-7 days	-12.70±3.75[B]	1.48±10.95[A]	-20.96±8.34[C]	**<0.001***
7-14 days	-1.02±4.73[A]	2.60±11.49[A]	-3.37±3.86[A]	**0.129**
14-28 days	10.37±4.13[A]	-19.35±10.77[B]	-15.13±7.62[B]	**<0.001***
2-28 days	-4.86±2.13[A]	-17.32±8.02[B]	-35.16±9.20[C]	**<0.001***

Different superscript letters indicate a statistically significant difference within the same horizontal row; *significant (p<0.05)

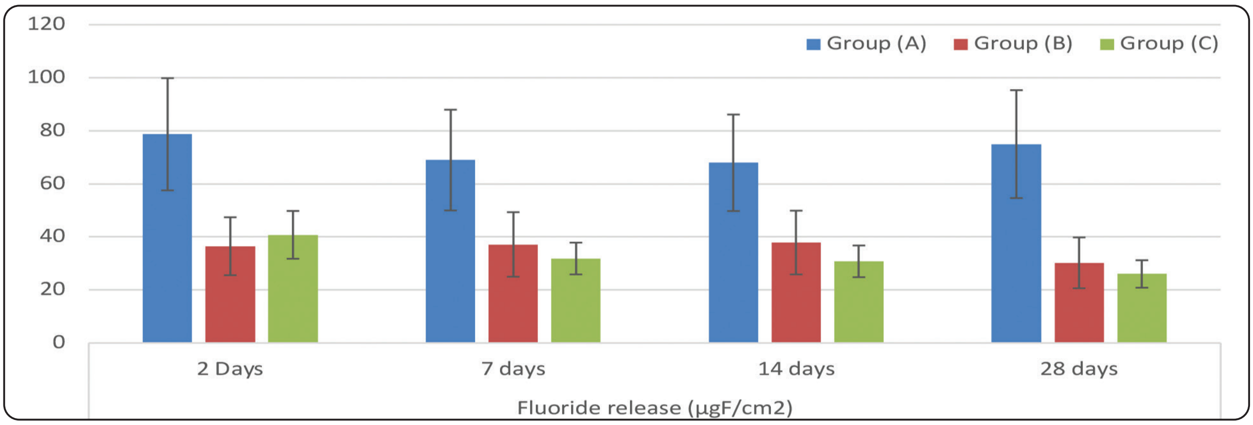

Fig. (1): Bar chart showing mean and standard deviation values of fluoride release (μgF/cm^2)

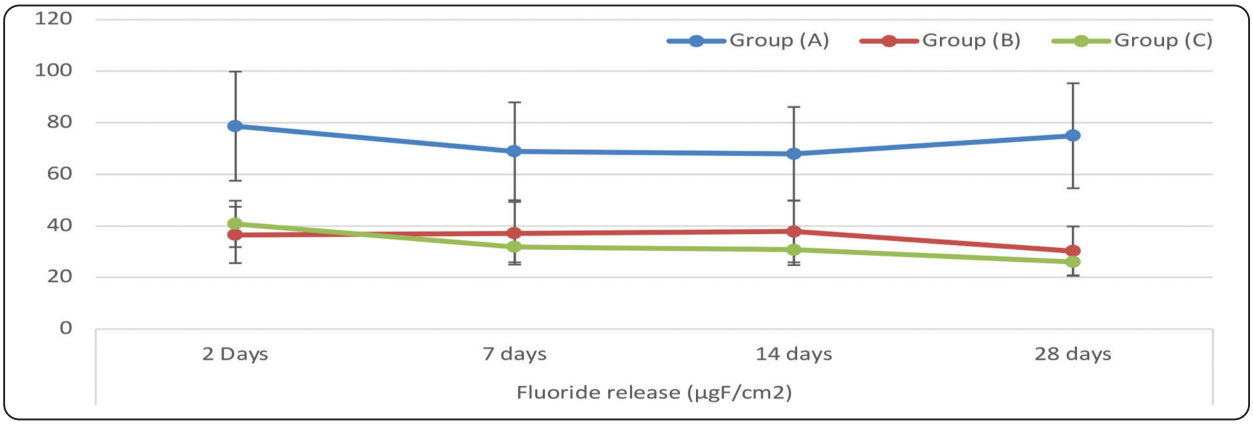

Fig. (2): Line chart showing mean and standard deviation values of fluoride release (µgF/cm2)

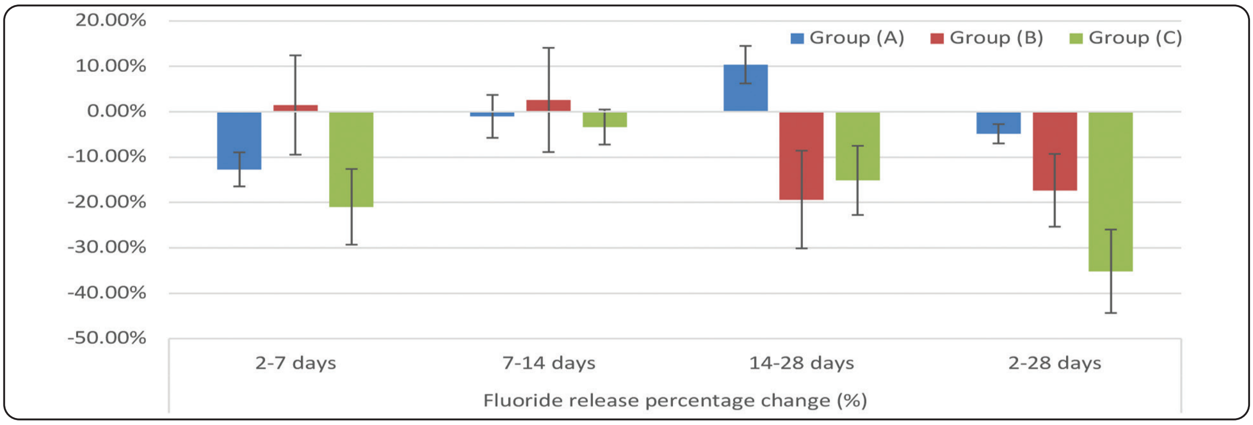

Fig. (3): Bar chart showing mean and standard deviation values of fluoride release percentage change (%)

DISCUSSION

Sustained fluoride release from glass ionomer cements has been shown in both in vivo and in vitro studies. However, reviewing the literature showed that there are considerably variable results on fluoride release from different restorative materials. This variability in results can be attributed to different methodology and specimen size, storage media, frequency of change of storage media, and quantity of media used to measure fluoride level [14].

In the present study, all the samples cavities were prepared by a single operator and restorative materials requiring mixing were strictly mixed according to manufacturer's recommendations to rule out any individual error.

Artificial saliva was used in this study as it is considered more clinically relevant than deionized water, organic acids and buffers as well as to better simulate the natural oral environmental conditions, although, exact mimicking of the properties of inconsistent and changeable nature saliva is undoable. However it should be mentioned that the amount of fluoride released in artificial saliva is lower than in deionized water [15]. Fluoride release was measured by Fluoride electrode coupled with standard pH meter method which is universally accepted method using Orion 901 microprocessor ion analyzer & Orion 407, this method allows fluoride in aqueous solution to be measured quickly, simply, economically & accurately [9]

In the present study maximum amount of fluoride release was observed by Fuji IX (RMGI) at

2 days followed by Ketac Molar (TGIC). Fluoride release by Fuji IX was declined from 2 days to 14 days with a significant increase afterwards. This could be reasoned with the "burst effect" a phenomenon of rapid diffusion of fluoride from the material during the first two days which is affected by particles' concentration and material matrix. After which, Fluoride release decreases rapidly and then stabilizes after 2 to 3 weeks. This pattern of initial high level of fluoride release is crucial for reducing bacterial viability and thus inducing caries inhibition through enamel/dentin remineralization and has been observed in previous studies [12, 14]. The results of this current study come in agreement with.

The result of the current study comes in agreement with a previous one reported Fuji IX releasing more fluoride than Ketac Molar over a 3 weeks period while in contrary, it disagrees with another study reported more fluoride release from Ketac Molar compared to Fuji IX over a period of 4 weeks [8, 16] .

The pattern of rapid release of fluoride by Fuji IX might be reasoned as a result of the process of controlled micro ionization of the glass ionomer particles. Smaller particles size provides a larger surface area, increasing acid-base reactivity, and capability of releasing fluoride more rapidly [17].

A good explanation for the difference of fluoride release pattern of different restorative materials tested is this study could be attributed to the pattern of setting reactions. For ketac Molar and Voco (TGIC), when powder and liquid are mixed, the glass particles undergo surface decomposition by proton attack. Fluoride ions are then liberated. TGIC show more extensive acid base reaction resulting in a better defined matrix. On the other hand, initial setting of Fuji IX (RMGI) is achieved through light activated polymerization followed by an acid base reaction. Type and amount of resin used for the photo-chemical polymerization reaction might affect the fluoride release from RMGI[18].

Results of the current study revealed that all the tested materials showed a decrease in the fluoride release during the following days. This could be due to slower dissolution of glass particles through the restorative materials over time. This was in agreement with other studies [19, 20].

Limitations of the current study could be specimen size and storage media. Further controlled clinical studies are needed to evaluate the clinical significance of the released fluoride of different restorative materials in the dynamic conditions of oral cavity. Factors related to fluoride diffusion site and rate influence its anti caries effectiveness which is the ultimate goal of conducting studies on fluoride release.

REFERENCES

1. Elderton, R.J., Preventive (evidence-based) approach to quality general dental care. Med Princ Pract, 2003. 12 Suppl 1: p. 12-21.
2. Subcommittee, A.A.o.P.D.C.A.C.R.D., Guideline on pediatric restorative dentistry. Pediatr Dent, 2012. 34(5): p. 173-80.
3. Craig, R., J. Power, and J. Wataha, Preventive dental materials in: Dental materials. 11th ed. 2015, St Louis: Mosby.
4. Alramady, D., et al., Remineralizing Ability of Resin Composite Incorporating Calcium Phosphate Nanoparticles and Fluoride Containing Adhesive. Al Azhar Dental Journal for Girls, 2022. 9(1): p. 39-46.
5. Hengtrakool, C., G.J. Pearson, and M. Wilson, Interaction between GIC and S. sanguis biofilms: antibacterial properties and changes of surface hardness. J Dent, 2006. 34(8): p. 588-97.
6. Pereira-Cenci, T., et al., Antibacterial agents in composite restorations for the prevention of dental caries. Cochrane Database Syst Rev, 2009(3): p. CD007819.
7. Garcez, R.M., M.A. Buzalaf, and P.A. de Araújo, Fluoride release of six restorative materials in water and pH-cycling solutions. J Appl Oral Sci, 2007. 15(5): p. 406-11.
8. Xu, X. and J.O. Burgess, Compressive strength, fluoride release and recharge of fluoride-releasing materials. Biomaterials, 2003. 24(14): p. 2451-61.

9. G Nigam, A., et al., Estimation of fluoride release from various dental materials in different media-an in vitro study. Int J Clin Pediatr Dent, 2009. 2(1): p. 1-8.

10. Faul, F., et al., G*Power 3: a flexible statistical power analysis program for the social, behavioral, and biomedical sciences. Behav Res Methods, 2007. 39(2): p. 175-91.

11. Mohamed, H., Comparative Study of Different Cavity Configuration Effect on Marginal Adaptation of Bulk Fill Versus Conventional Resin Composites. Al-Azhar Assiut Dental Journal, 2021. 4(2): p. 129-139.

12. Virmani, S., M.N. Hegde, and S.S. Shetty, Vandana., Comparative Evaluation of Fluoride Release from Three Glass Ionomer Cements – An in vitro Study. Current Journal of Applied science and technology, 2016. 18(4): p. 1-6.

13. R Development Core Team, R: A language and environment for statistical computing. 2021, R foundation for statistical computing: Vienna, Austria.

14. Mousavinasab, S.M. and I. Meyers, Fluoride release by glass ionomer cements, compomer and giomer. Dent Res J (Isfahan), 2009. 6(2): p. 75-81.

15. Yusoff, N.N.A.b.N., et al., Fluoride Release from Dental Restorations in De-Ionized Water and Artificial Saliva. International Medical Journal, 2013. 20(5): p. 635-638.

16. Mazzaoui, S.A., et al., Incorporation of casein phosphopeptide-amorphous calcium phosphate into a glass-ionomer cement. J Dent Res, 2003. 82(11): p. 914-8.

17. Wiegand, A., W. Buchalla, and T. Attin, Review on fluoride-releasing restorative materials--fluoride release and uptake characteristics, antibacterial activity and influence on caries formation. Dent Mater, 2007. 23(3): p. 343-62.

18. Bansal, R. and T. Bansal, A Comparative Evaluation of the Amount of Fluoride Release and Re-Release after Recharging from Aesthetic Restorative Materials: An in vitro Study. J Clin Diagn Res, 2015. 9(8): p. ZC11-4.

19. Vermeersch, G., G. Leloup, and J. Vreven, Fluoride release from glass-ionomer cements, coomposites. J Oral Rehabil, 2001. 28(1): p. 26-32.

20. Abdallah, A., T. ElShehawy, and H. Ibrahim, Fluoride Release and Recharge Behavior of Bioactive Glass Ionomer Cements using Ion Chromatography. Egyptian Dental Journal, 2019. 65: p. 399-406.