FLUORIDE RELEASE FROM VARIOUS RESTORATIVE MATERIALS OVER A 3 MONTH PERIOD - AN IN VITRO STUDY

Patil S.A.*, Goud K.M., Sajjan G.S.*****

Background: Fluorides are the most commonly used anti caries agents and for this unique property they are incorporated into various restorative materials for the same. The effectiveness of the restorative materials in preventing caries depends on the duration of fluoride release from the material.

Aim: To evaluate short and long term fluoride release profiles from a glass ionomer (Fuji II GC), a resin modified glass ionomer (vitremer) and a compomer (dyract).

Materials and Method: Disc shaped specimen of the glass ionomer (Fuji II GC), a resin modified glass ionomer (vitremer) and a compomer (dyract) were formed and were suspended in de ionized water upto a period of 3 months, and fluoride release was measured using Orion Fluoride Electrode and Ion Analyzer.

Results: The results showed that conventional glass ionomer cement showed the highest fluoride release at any point of time followed by Resin modified glass ionomer cement and later by compomer ($p<0.05$).

Key words: fluoride, glass ionomer cement, resin modified glass ionomer cement, compomer, deionized water.

As far as the field of dentistry is concerned, the discovery of fluorides represents an epoch making event. Fluoride has been documented as an effective anticariogenic agent since decades, and this beneficial effect on the human dentition has led to the examination of available fluoride in a host of dental materials.[1] Delivery of fluoride to the susceptible tooth surface is best facilitated by the release from fluoride containing restorative materials.[2] The released fluoride from the restoration acts as a topical application to increase the fluoride content of the surrounding tooth structure thereby minimizing the caries by forming fluor apatite crystals which are more resistant to acid attack.

Glass ionomer cement have gained a established position in restorative dentistry. The interest in the clinical use of glass ionomer cement arises mainly from its behavior as an adhesive bioactive material with therapeutic action.[3,4]

The resin modified glass ionomer are more easily placed, more esthetic and more resistant to moisture than the conventional glass ionomer cements.[5]

The advancements in development of restorative materials a successor for composite was developed which was termed as "compomer" also known as "polyacid modified resin composites".[6]

While the studies indicate the benefit of fluoride release from some materials, only a few of provide information regarding relative levels of fluoride release.[7] It is however, clear that there are differences in the effectiveness of materials that are likely related to their levels of fluoride release.

The current study was carried out to evaluate and compare the fluoride release characteristics and profiles of conventional glass ionomer cement, a resin modified glass ionomer and a compomer.

Materials and methods:

The study was carried out at the Department of Conservative Dentistry, Bapuji Dental College and Hospital, Davangere, Karnataka, India in

* *Assistant Professor, Department of Conservative Dentistry and Endodontics, SDM College of Dental Sciences and Hospital, Dharwad, Karnataka-580009.*
** *Professor*
*** *Professor and Head Department of Conservative Dentistry and Endodontics, Bapuji Dental College and Hospital, Davangere, Karnataka-577004.*

collaboration with Department of Chemical Engineering, Bapuji Institute of Engineering and Technology, Davangere, Karnataka, India.

The following test materials were used in the study, which were grouped as follows:

Group I : A conventional glass ionomer (Restorative) – Fuji II (GC)

Group II : A resin modified glass ionomer – Vitremer (3M)

Group III : A compomer – Dyract, (Dentsply De Tery)

Fluoride release from respective test materials was measured for a period of 3 months.

A total of 24 discs of 8.6 mm in diameter and 1.65 mm in depth of the test materials were made by inserting the materials in the Teflon mold following manufacturers' instructions. 8 discs were made for each group of test materials. During the setting of the cements a dental floss was incorporated into the test materials. A glass plate was used to cover the open end of the mold during curing procedures. The discs were then polished using Super Snap polishing discs (3M). These discs were individually suspended in polyethylene containers with 25 ml of de-ionized water and stored at 37^{0}C until the time of each measurement. To measure the fluoride concentration in water, 10 ml aliquot was removed and added to 10ml of TISAB (total ionic strength adjusting buffer)[8]. An Orion fluoride electrode with Orion ion analyzer was used to measure the concentration of eluted fluoride in the solution (in ppm). The discs were returned to their respective containers with fresh de-ionized water and stored at 37^0 C till the next measurement. The fluoride release by the materials was measured at the end of 24 hours and on the 2,4,6,8 days and long term fluoride release was measured every month for a period of 3 months.

Results

The current study was carried out to evaluate the amount of fluoride release by the three restorative materials; glass ionomer cement, resin modified glass ionomer cement and compomer over a period of three months and the total amount of fluoride released was analyzed and compared between the test materials.

The GIC released 30.58$\pm$1.28ppm of fluoride at the end of 24 hours as compared to 20.69 $\pm$0.48 ppm released by RMGIC and, 11.40$\pm$0.43 ppm released by compomer. The maximum amount of fluoride released by all the three materials was at the end of 24 hours. There was a statistically significant difference between the 3 materials. Over a period of three months the amount of fluoride by all the three materials decreased continuously. At the end of three months the fluoride released was 2.18$\pm$0.25 ppm for GIC, 1.43 $\pm$0.18 ppm for RMGIC, 0.66+ 0.06 ppm for compomer respectively.

GIC released the highest amount of fluoride as compared to the other two materials at any given point of time and was statistically significant as shown on table 1.

The pair wise comparison for the three materials is as shown in table 2. The amount of fluoride released by the GIC was statistically significant as compared to RMGIC and compomer and the amount of fluoride released by RMGIC was statistically significant as compared to compomer. The fluoride release continued till the end of 3 months for all the three materials.

Discussion

A sustained fluoride release and an intimate contact of the restoration to the tooth margin are needed to facilitate the exchange of fluoride into the hydroxyapatite of the surrounding enamel[9]. There is sufficient evidence regarding fluoride release from materials inhibiting the demineralization of enamel adjacent to such materials.[7]

Both resin modified glass ionomer and the compomer have got desirable properties as compared to GIC's. These materials combine the best of both composites and GIC's. Both of these materials have an inherent property of fluoride release over a period of time.

When the fluoride release profile was carried out for all the three materials, it was observed that the highest release of fluoride was eluted in the first 24 hours and the levels dropped after a certain period but fluoride release continued for long periods. This is in accordance with the study by Crisp et al 1980; Meryon and Smith 1984; and Mallakh and Sarkar 1990.[10,11] This increased level of fluoride in the first 24hrs is due to the high early erosions of GIC.

Table1: ANOVA Comparison of the 3 groups for fluoride release at between the 3 groups at various time:

	Group	Means	Std.Dev.	F-value	p-value
24 hrs	Group I	30.58	1.23	1149.68	**0.00**
	Group II	20.69	0.48		
	Group III	11.40	0.43		
	Group I	19.41	0.65	1306.11	**0.00**
2 days	Group II	14.18	0.33		
	Group III	8.23	0.22		
	Group I	13.57	0.27	564.41	**0.00**
4 days	Group II	8.88	0.49		
	Group III	5.79	0.58		
	Group I	9.12	0.41	600.87	**0.00**
6 days	Group II	7.15	0.11		
	Group III	4.41	0.21		
	Group I	7.36	0.47	196.83	**0.00**
8 days	Group II	6.58	0.35		
	Group III	3.74	0.32		
	Group I	5.53	0.39	151.86	**0.00**
1 month	Group II	4.36	0.35		
	Group III	2.77	0.18		
	Group I	3.36	0.33	201.67	**0.00**
2 months	Group II	2.43	0.21		
	Group III	1.09	0.03		
	Group I	2.18	0.25	139.52	**0.00**
3 months	Group II	1.43	0.18		
	Group III	0.66	0.06		

Significance at p value $p<0.05$

Table 2: Pairwise comparison by Newman-Keuls multiple post hoc tests:

	Group	Group I	Group II	Group III
	Mean	30.58	20.69	11.40
24hrs	Group I	-		
	Group II	**0.00**	-	
	Group III	**0.00**	**0.00**	-
	Mean	19.41	14.18	8.24
2 day	Group I	-		
	Group II	**0.00**	-	
	Group III	**0.00**	**0.00**	-
4 day	Mean	13.57	8.88	5.79
	Group I	-		
	Group II	**0.00**	-	
	Mean	9.11	7.15	4.42
6 day	Group I	-		
	Group II	**0.00**	-	
	Group III	**0.00**	**0.00**	-
	Mean	7.36	6.58	3.74
8 day	Group I	-		
	Group II	**0.00**	-	
	Group III	**0.00**	**0.00**	-
	Mean	5.53	4.36	2.77
1 month	Group I	-		
	Group II	**0.00**	-	
	Group III	**0.00**	**0.00**	-
	Mean	3.36	2.43	1.09
2 month	Group I	-		
	Group II	**0.00**		
	Group III	**0.00**	**0.00**	-
3 month	Mean	2.18	1.43	0.66
	Group I	-		
	Group II	**0.00**	-	
	Group III	**0.00**	**0.00**	-

Significance at p value $p<0.05$

Conventional GIC releases significant levels of fluoride. This material is classified as "a water based material that harden following an acid base reaction between fluor alumino silicate glass powder and an aqueous solution of polyacid".[12] The increased level of fluoride is due to erosive leaching of glass particles in the bulk of cement and diffusion of the leached fluoride through the porous cement matrix.

The lesser fluoride release from the RMGI and can be attributed to its setting reaction, Wilson (1990) described the setting reaction of RMGI as "*dual setting*", in which both polymerization and acid base reaction take place.[13] The latter takes place by the virtue of HEMA, which is a hydrophilic monomer which absorbs water and results in the reaction.

The lower release of fluoride from Group III (Compomer) can be explained by the fact that these products are hydrophobic resins which set by polymerization.[14] They do not contain water, as seen in Conventional and Resin Modified Glass Ionomers, but they absorb water after weeks of curing thereby resulting in an acid base reaction, which is secondary. As a result the amount of fluoride released by this group is lesser than Group I and II.

As the amount of fluoride eluted has a direct effect on inhibition of secondary caries, it can be thought that higher the fluoride release, better the material. But, when selecting a material for clinical use, considering the clinical needs, solubility and other physical properties along with the amount of fluoride release is necessary.

Conclusion

The following conclusions were drawn from the study:

The conventional Glass Ionomer Cement (Fuji II) releases the highest amount of fluoride followed by RMGI (Vitremer) and later followed by Compomer (Dyract), and the highest amount of fluoride eluted is at the end of 24 hours after which consistently lower amount of fluoride elution is observed which occurs over long periods of time.

References

1. Donly K.J. and Ingram C.: An in vitro caries inhibition of photopolymerized glass ionomer liners. *Journal of Dentistry for Children*. 1997; 128-130.
2. Freed man R. and Diefenderfer K.E.: Effects of daily fluoride exposures on fluoride release by glass ionomer-based restoratives. *Operative Dentistry*. 2003; 28(2) : 178-185.
3. De Moor R.J.G., Verbeeck R.M.H.: Effects of acetic acid on the fluoride release profiles of restorative glass ionomer cements. *Dent Mater*. 1998 ; 14 : 261-268.
4. De Moor R.J.G., Verbeeck and De Maeyer E.A.P.: Fluoride release profiles of restorative glass ionomer formulations. *Dent Mat*. 1996;12:88-95.
5. Forss H.: Release of fluoride and other elements from light cured glass ionomers in Neutral and Acidic Conditions. *J Dent Res*. 1993 ; 78 (2) : 1257-1262.
6. Chadwick S.M. and Gordon P.H.H.: An investigation into the fluoride release of a variety of orthodontic bonding agents. *Br J. orthodont*. 1995; 22: 29-33.
7. Anusavice K.J.: Phillips Science of Dental Materials, 11th Edition.
8. De Araujo F.B. et al: Fluoride release from fluoride-containing materials. Operative Dentistry. 1996 ; 21 :185-190.
9. Bronwen Vorhies A. et al: Enamel demineralization adjacent to orthodontic bracket bonded with hybrid glass ionomer cements : An in vitro study. *Am J Orthod Dentofacial Orthop*. 1998; 114 :668-74.
10. El Mallakh B.F. and Sarkar N.K. : Fluoride release from glass ionomer cements in de-ionized water and artificial saliva. *Dent Mater*. 1990 ; 6: 118-122.
11. Creanor S.L; et al: Fluoride uptake and release characteristics of glass ionomer cements. Caries Res. 1994 ; 28: 322-328.
12. Carel L. Davidson and Ivar A Mjor : Advances in Glass Ionomer Cements. Quintessence Publishing Co. Inc. 1999.
13. Damato F.A., Strang R. and Stephen K.W. : Effect of fluoride concentration on remineralization of carious enamel: an in vitro pH – Cycling study. Caries Res. 1990 ; 24 :174-180.
14. Harry F Albers: Tooth coloured restoratives – Principles and Techniques, 9th Edition. DC Decker Inc 2002