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RESEARCH ARTICLE

COMPARATIVE EVALUATION OF FLUORIDE RECHARGE OF FLUORIDE RELEASING DENTAL MATERIALS BY FLUORIDATED DENTIFRICE : AN IN VITRO STUDY

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Abstract

Introduction: Fluoride releasing dental materials releases maximum fluoride within twenty four hours which reduces thereafter.If we could recharge fluoride on the daily basis,the caries preventive effect from fluoride releasing dental materials can be prolonged.

Aim and Objectives: The present study is undertaken to compare and evaluate fluoride recharge of fluoride releasing dental materials by fluoridated dentifrice.

Materials and Method: Materials used in this study are GC Fuji Type IX,Fuji Plus,Zirconomer Improved,Beautifil II LS. All restorative materials were mixed according to manufacturer's instruction and standardized test pellets were made using autoclaved instruments in sterile plastic moulds. These test pellets were divided in various groups and brushed with fluoridated dentifrice accordingly . Results were evaluated statistically using Post Hoc test and ANOVA and correlation coefficient for which regression lines were drawn.

Result: The mean fluoride release and recharge was maximum in Zirconomer Improved, followed by GC Fuji Plus ,then by GC Fuji Type IX and least by Beautifil II LS.

Conclusion: Daily recharge of fluoride releasing dental materials with fluoridated dentifrices is recommended to increase the cariostatic effect.

Introduction:-

Oral health is an essential part of general health and well being and is important factor in individual's quality of life. Dental caries is one of the most common oral health disease.According to WHO,Dental caries is a microbial multifactorial disease of calcified tissue of teeth,characterized by demineralization of the inorganic content and destruction of organic content. A world wide accepted means of preventing dental caries is fluoride.So many studies were conducted on this.A study by A Groeneveld et al stated that fluoride can decrease dental caries, incidence of pit

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and fissure caries by 66% and smooth surface caries by 25%[1].But inspite of regular usage of fluoride caries still occur.Once it occur,it has to be restored.

If we restore these carious lesion with fluoride releasing restorative materials,we can prevent further lesions in and around those restorations. Fluoride strengthens teeth and prevents their decay[2].When pH decreases below 5.5,under saturation with calcium and phosphate with respect to hydroxyapatite is reached in the biofilm fluid,resulting in mineral dissolution[2].When fluoride is present in oral fluids fluoroapatite formation occurs during the remineralization process resulting in a stronger,fluoridated tooth mineral(fluoroapatite).It is less soluble than hydroxyapatite and more resistant to demineralization[2].

The most commonly used material with high fluoride releasing property is Glass ionomer cement,which has good esthetics,anticariogenic property,good compressive strength, but poor tensile and shear bond strength[3].To overcome the shortcomings of Glass ionomer cement while maintaining their clinical advantage in caries inhibition,hybrid materials that purportedly combine the benefits of Glass ionomers and composite resins were developed like Resin modified Glass ionomers (RMGICs),compomers and Giomers[3]. Zirconomer improved,Fuji plus,Beautifil II LS are some of the newly evolved fluoride releasing materials[4].

Zirconomer improved is a reliable and durable tooth coloured zirconia reinforced fluoride rich posterior restorative.It is considered as a safe alternative to silver amalgam with protective benefits of Glass ionomer[4].Fuji plus is a resin reinforced,glass ionomer luting cement.It has high bond strength in addition to fluoride release property[3].Beautifil II LS is a low shrinking fluoride releasing composite for anterior and posterior with maximum esthetics.

But, fluoride release from fluoride releasing dental materials is maximum within 24 hours and thereafter it reduces to a very low level[5].So if we are able to recharge fluoride on a daily basis by using fluoridated dentifrices, then we can have increased protection from recurrent carious lesions or newer lesions[6].

Hence in light of the above knowledge the present in vitro study intended to explore comparative evaluation of fluoride recharge of GC Fuji Type IX,GC Fuji plus, zirconomer improved, Beautifil II LS by fluoridated dentifrice.

Aim:

1) To compare and evaluate fluoride recharge of fluoride releasing dental materials by fluoridated dentifrice

Objectives:-

1. To compare and evaluate fluoride release from various restorative materials using spectrophotometer
2. To compare and evaluate fluoride recharge from restorative materials after fluoridated dentifrice using spectrophotometer

Materials And Methods:-

Materials used for the study and it's composition(Table-1)

1. GC Fuji plus (shofu)
2. Zirconomer Improved(shofu)
3. GC Fuji Type IX (Gold Label IX Posterior Restorative)
4. Beautifil II LS(shofu)

Material	Manufacturer	Composition
GC Fuji plus	SHOFU	Powder:fluoroalumino silicate glass,polyacrylic acid Liquid:Polyacrylic acid,polybasic carboxylic acid,distilled water
Zirconomer Improved	SHOFU	Powder:Fluoroaluminosilicate glass,zirconomer oxide,pigments Liquid:Polycarboxylic acid solution and tartaric acid
GC Fuji Type IX	GC CORPORATION TOKYO,JAPAN	Powder:Fluoro alumina silicate glass,polyacrylic acid

		Liquid:Distilled water,polyacrylic acid,tartaric acid,poly basic carboxylic acid
BEAUTIFIL II LS (Low shrinkage)	SHOFU	Bis GMA,TEGDMA,S-PRG Filler,ML-01 monomer

Table 1:- Materials used for the study and it's compoisition.

Methodology:-

The restorative materials viz. GC Fuji Type IX,Fuji Plus,Zirconomer Improved,Beautifil II LS were mixed according to manufacturer's instructions and 40 pellets (10 of each material)-(figure-1) were made using autoclaved instruments in sterile plastic cylindrical moulds [4 mm (diameter) x 2mm (ht.)], supported by a glass slab. Each group was further divided into 4 experimental subgroups with five pellets in each subgroup. Specimens were stored in 10ml deionized water.(figure-2)

Figure 1:-Material pellets

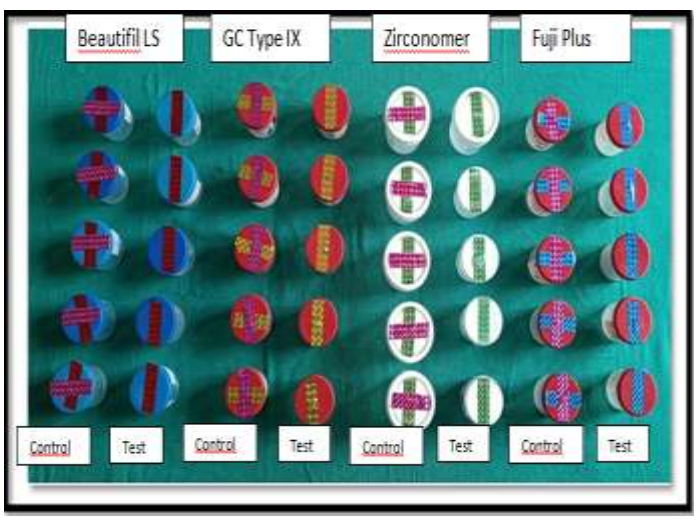


Figure 2:- Specimens in storage media.

Division Of Samples:-

The prepared moulds were randomly divided into four groups and colour coded accordingly
Group I-(Yellow) restored with Zirconomer improved

Group Ia-Control group (n=5)
Group Ib-Experimental group (n=5)
Group II-(Green) restored with GC Fuji Type 1X
Group IIa-Control group (n=5)
Group IIb-Experimental group (n=5)
Group III-(Blue) restored with GC Fuji plus
Group IIIa-Control group (n=5)
Group IIIb-Experimental group(n=5)
Group IV-(Red) restored with Beautifil II LS
Group IVa-Control group (n=5)
Group IVb-Experimental group (n=5)

A common fluoridated tooth paste and separate tooth brush for each material was used to brush restorative material pellets belonging to the experimental subgroup of each group for 2 minutes twice daily.The restorative material pellets were taken out from the storage containers with the help of a tweezer and dried with a chip blower.fluoridated dentifrice was dispensed in atooth brush and then the pellet was brushed on both sides for 2 minutes and then washed for 30 seconds using running tap water. Deionized water in storage container was changed every 24 hours

The deionized water of each restorative pellets from all the groups, were then subjected to evaluation of fluouride release in 1st day,7th dy,15th day using spectrophotometer (figure-3)

Figure 3:- Spectrophotometer showing readings.

Statistics:-
The data was statistically analyzed using analysis of variance (ANOVA) test and Post Hoc Analysis test. The relation between different groups was obtained by correlation coefficient for which regression lines were drawn.

Result And Observations:-

The mean fluoride release in the test group (brushed group) at the day 1 in the Group I was 13.204 and in the control group (non brushed group), it was 12.128 . At the 7th day the mean fluoride release was 7.620 in the control group and 8.924 in the test group.While at the 15th day, it reduced to 2.648 in the control group and 4.248 in the test group. The intergroup comparison between the test and control group at 1st day, 7th day and 15th day was done using the independent t test . The mean fluoride release was significantly higher in the test group as compared to the control group (p=0.001) at all the time intervals (Table-2)

Table 2:- Intergroup comparison between means of test and control groups in zirconomer improved (GroupI).

	Groups	Mean	Std. Deviation	Std. Error Mean	P value
DAY 1	Control	12.128	0.319	0.142	0.001
	Test	13.204	0.288	0.129	

DAY7	Control	7.620	0.375	0.167	0.013
	Test	8.924	0.835	0.373	
DAY15	Control	2.648	0.298	0.133	0.001
	Test	4.248	0.451	0.202	

p value less than 0.05 is significant and more than 0.05 is non significant

The mean fluoride release in the test group(brushed group) at the day 1 in the Group II was 11.464 and in the control (non brushed group) group it was 10.622. At the 7th day the mean fluoride release was 3.506 in the control group and 4.410 in the test group.While at the 15th day,it reduced to 1.458 in the control group and 2.494 in the test group. The intergroup comparison between the test and control group at 1st day, 7th day and 15th day was done using the independent t test . The mean fluoride release was significantly higher in the test group as compared to the control group (p=0.001) at all the time intervals (Table-3)

Table 3:- Intergroup comparison between means of test and control groups in GC Fujitype IX(GroupII).

	Groups	Mean	Std. Deviation	Std. Error Mean	P value
DAY1	Control	10.622	0.296	0.132	0.001
	Test	11.464	0.253	0.113	
DAY7	Control	3.506	0.369	0.165	0.001
	Test	4.410	0.313	0.140	
DAY15	Control	1.458	0.339	0.151	0.001
	Test	2.494	0.323	0.144	

p value less than 0.05 is significant and more than 0.05 is non significant

The mean fluoride release in the test group(brushed group) at the day 1 in the Group III was 12.576 and in the controlgroup(non brushed group) it was 11.36. At the 7th day the mean fluoride release was 4.814 in the control group and 6.350 in the test group. While at the 15th day it reduced to 3.690 in the control group and 4.772 in the test group. The intergroup comparison between the test and control group at 1st day, 7th day and 15th day was done using the independent t test. The mean fluoride release was significantly higher in the test group as compared to the control group (p=0.001) at all the time intervals (Table-4)

Table 4:- Intergroup comparison between test and control groups in GC Fuji Plus(Group III).

	Groups	Mean	Std. Deviation	Std. Error Mean	P value
DAY1	Control	11.360	0.371	0.166	0.001
	Test	12.576	0.278	0.124	
DAY7	Control	4.814	0.421	0.188	0.001
	Test	6.350	0.370	0.165	
DAY15	Control	3.690	0.343	0.153	0.001
	Test	4.772	0.119	0.053	

p value less than 0.05 is significant and more than 0.05 is non significant

The mean fluoride release in the test group (brushed group) at the day 1 in the Group IV was 8.55 and in the control group (non brushed group) was 7.362. At the 7th day, the mean fluoride release was 2.704 in the control group and 3.93 in the test group.While at the 15th day,it reduced to 0.866 in the control group and 1.57 in the test group. The intergroup comparison between the test and control group at 1st day, 7th day and 15th day was done using the independent t test. The mean fluoride release was significantly higher in the test group as compared to the control group (p=0.001) at all the time intervals (Table-5)

Table 5:- Intergroup comparison between test and control groups in beautifil II LS (Group IV).

	Groups	Mean	Std. Deviation	Std. Error Mean	P value
DAY1	Control	7.362	0.373	0.167	0.001
	Test	8.550	0.353	0.158	
DAY7	Control	2.704	0.298	0.133	0.001
	Test	3.930	0.210	0.094	
DAY15	Control	0.866	0.071	0.031	0.001
	Test	1.570	0.272	0.122	

p value less than 0.05 is significant and more than 0.05 is non significant

In the test group(brushed group) at the day1 the mean fluoride release was 13.204 in the Group I, 11.464 in the Group II, 12.576 in the Group III and 8.55 in the Group IV. At the day 7 the mean fluoride release was 8.924 in the Group I, 4,416 in the Group II, 6.35 in the Group III and 3.93 in the Group IV. While at the 15th day the mean fluoride release was reduced to 4.248 in the Group I, 2.494 in the Group II, 4.772 in the Group III and 1.57 in the Group IV. The intergroup comparison between the four groups at 1st day, 7th day and 15th day was statistically significant when analyzed using One way ANOVA at p value less than 0.001.(Table-6)

Table6:- One Way ANOVA between the four groups.

		Sum of Squares	Df	Mean Square	F	Sig.
DAY1	Between Groups	63.773	3	21.258	242.743	0.001
	Within Groups	1.401	16	.088		
	Total	65.174	19			
DAY7	Between Groups	77.151	3	25.717	105.191	0.001
	Within Groups	3.912	16	.244		
	Total	81.062	19			
DAY15	Between Groups	33.523	3	11.174	112.512	0.001
	Within Groups	1.589	16	.099		
	Total	35.112	19			

p value less than 0.05 is significant and more than 0.05 is non significant

In the test group (brushed group) at the day1 the mean fluoride release was 13.204 in the Group I, 11.464 in the Group II, 12.576 in the Group III and 8.55 in the Group IV.. At the day 7 the mean fluoride release was 8.924 in the Group I, 4,416 in the Group II, 6.35 in the Group III and 3.93 in the Group IV. At the 15th day the mean fluoride release was 4.248 in the Group I, 2.494 in the Group II, 4.772 in the Group III and 1.57 in the Group IV. When the post hoc analysis was -done the intergroup comparison was significant between Group I-Group II, Group I-Group III, Group I-Group IV, Group II-Group III, Group II-Group IV, Group III and Group IV at the Day 1,At the Day 7, the intergroup comparison was significant between Group I-Group II, Group I-Group III, Group I-Group IV, Group II-Group III, Group II-Group IV, Group III and Group IV. At the day 15 the intergroup comparison was significant between Group I-Group II, Group I-Group III, Group I-Group IV, Group II-Group III, Group II-Group IV, Group III and Group IV(Table-7)

Table 7:-Post Hoc Analysis of intergroup comparison of test group.

		Mean Difference	Std. Error	P value
DAY1	Group I vs Group II	1.740	0.187	0.001
	Group I vs Group III	0.628	0.187	0.001
	Group I vs Group IV	4.654	0.187	0.001
	Group II vs Group III	1.112	0.187	0.001
	Group II vs Group IV	2.914	0.187	0.001
	Group III vs Group IV	4.026	0.187	0.001
DAY7	Group I vs Group II	4.508	0.312	0.001
	Group I vs Group III	2.574	0.312	0.001
	Group I vs Group IV	4.994	0.312	0.001
	Group II vs Group III	1.934	0.312	0.001
	Group II vs Group IV	0.486	0.312	0.001
	Group III vs Group IV	2.420	0.312	0.001
DAY15	Group I vs Group II	1.754	0.199	0.001
	Group I vs Group III	-0.524	0.199	0.001
	Group I vs Group IV	2.678	0.199	0.001
	Group II vs Group III	-2.278	0.199	0.001

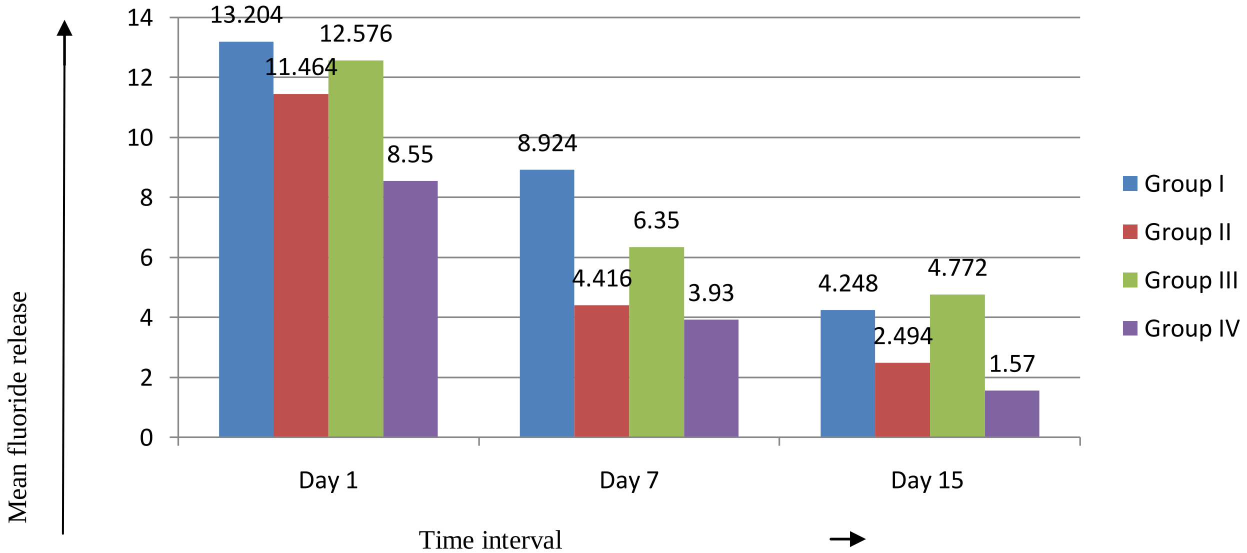
	Group II vs Group IV	0.924	0.199	0.001
	Group III vs Group IV	3.202	0.199	0.001
p value less than 0.05 is significant and more than 0.05 is non significant				

In the control group at the day1 the mean fluoride release was 12.128 in the Group I, 10.622 in the Group II, 11.36 in the Group III and 7.362 in the Group IV.. At the day 7 the mean fluoride release was 7.62 in the Group I, 3.506 in the Group II, 4.814 in the Group III and 2.704 in the Group IV. At the 15th day the mean fluoride release was 2.648 in the Group I, 1.458 in the Group II, 3.69 in the Group III and 0.866 in the Group IV. When the post hoc analysis was done the intergroup comparison was significant between Group I-Group II, Group I-Group III, Group I-Group IV, Group II-Group III, Group II-Group IV, Group III and Group IV at al the three time intervals

Table 8:-Post Hoc Analysis of intergroup comparison of test group.

		Mean Difference (I-J)	Std. Error	Sig.
DAY1	Group I vs Group II	1.506	0.216	0.001
	Group I vs Group III	0.768	0.216	0.001
	Group I vs Group IV	4.766*	0.216	0.001
	Group II vs Group III	0.738	0.216	0.001
	Group II vs Group IV	3.260	0.216	0.001
	Group III vs Group IV	3.998	0.216	0.001
DAY7	Group I vs Group II	4.114	0.233	0.001
	Group I vs Group III	2.806	0.233	0.001
	Group I vs Group IV	4.916	0.233	0.001
	Group II vs Group III	1.308	0.233	0.001
	Group II vs Group IV	0.802	0.233	0.001
	Group III vs Group IV	2.110	0.233	0.001
DAY15	Group I vs Group II	1.190	0.181	0.001
	Group I vs Group III	1.042	0.181	0.001
	Group I vs Group IV	1.782	0.181	0.001
	Group II vs Group III	2.232	0.181	0.001
	Group II vs Group IV	0.592	0.181	0.001
	Group III vs Group IV	2.824	0.181	0.001
p value less than 0.05 is significant and more than 0.05 is non significant				

Comparison Of Mean Fluoride Release Of Different Dental Materials(Graph-1)



Graph 1:- Mean fluoride release of various dental materials at different time intervals.

Discussion:-

Dental caries, otherwise known as tooth decay, is one of the most prevalent chronic diseases of people worldwide; individuals are susceptible to this disease throughout their lifetime[44]. Dental caries forms through a complex interaction over time between acid-producing bacteria and fermentable carbohydrate, and many host factors including teeth and saliva[44].Worldwide accepted means of preventing dental caries is fluoride .

Fluoride was introduced into dentistry over 70 years ago, and it is now recognized as the main factor responsible for the dramatic decline in caries prevalence that has been observed worldwide[45].Fluoride prevents demineralization of tooth structure,promotes remineralization and inhibits antimicrobial action.The era of fluoridated dentifrices began during the 1950's. The benefits ofcompatibility formulated dentifrices are well established and their use is believed to be partly responsible for generalized caries decline.But caries being a multifactorial disease, inspite of many preventive measures it has been seen to occur time and again. And once it occurs it needs to be restored otherwise it will spread deeper and eventually the tooth will be lost.

Therefore, it was thought to incorporate fluoride into the structure of the restorative material so that it would be caries preventive[23].With the introduction of fluoride releasing dental materials, an option for simultaneously restoring the clinically evident caries along with protection against recurrent caries became available[17].The materials commonly used as fluoride releasing restorative materials are silicates,conventional glass ionomers, resin hybrid glass ionomers, fluoride releasing compositeresins, fluoride releasing pit and fissure sealants.But these fluoride releasing materials release fluoride in an initial burst and thenreduce exponentially to a much lower steady state level of release in few days.

The most popular restorative material in pediatric dentistry has been Glass Ionomer Cement. Since its inception in **1960 by Kent and Wilson** Glass Ionomer cement has gained success as a restorative, luting as well as lining material in pediatric dentistry[46].It has been widely used in dentistry to have long- term durability in the oral cavity and be an excellent barrier against caries. One of the major drawbacks of conventional GIC is its weak mechanical properties like brittleness,low strength, and toughness. To overcome the drawbacks, the conventional GIC has undergone innumerable changes and inclusions in its properties and composition. Thus in recent times materials with increased strength than GIC but retaining the features like esthetics, anti-cariogenic potential and chemo-mechanical attachment with tooth structure has been into practice.

Manufacturers worked diligently to produce GIC systems that overcome the disadvantages of this class of materials like poor resistance to fracture. The need to improve the mechanical properties of GICs was always a major concern.

There had been considerable interest by manufacturers and researchers to improve the formulation of GIC and also to overcome some of its drawbacks.

In view of these shortcomings, attention was directed at improving the mechanical properties and handling characteristics of glass ionomer cements. Resin modified glassionomer cements (RMGIC) were introduced in 1988 by Antonucci et al to overcome the problems associated with the conventional Glass ionomers and at the same time preserving the clinical advantage of conventional GIC. Resin in RMGI is obtained by first putting the monomer into the liquid component of the GIC and then photo polymerization. But again due to early moisture contamination, the restoration would lack its durability eventually.

The optimum fluoride level needed to stop caries progression still remains unknown. However, providing a source for maintained fluoride release from a restoration would be beneficial. Therefore, search for a material that has the fluoride releasing capability of conventional glass ionomer and the durability of composites led to the further evolution, combining light cured composite resin and GIC technology[46] .

A recently a new category of hybrid aesthetic restorative material which differs from both resin modified glass ionomer and composites has been introduced by Shofu Inc. (Kyoto, Japan 2000) known as GIOMERS, in which they created a Stable Glass-ionomer phase on a glass core and induced an acid-base reaction between fluoride containing glass and polycarboxylic acid in the presence of waterdeveloped as Pre-Reacted Glass-ionomer (PRG) filler. In early 2000s it was Robert et al. who first remarked the fact that the fluoride releasing mechanism of glass ionomer cement was derived from its acid-base reaction phase between ion leachable fluoroaliminosilicate glass and polyalkenoic acid in permeable polyalkenoate matrices, and newly developed a revolutionary Prereacted glass ionomer (PRG) filler technology. This PRG technology was applied to the filler component of resin composite materials to provide a bioactive result that released and was recharged with fluoride-like a traditional glass ionomer cement-all the while maintaining the original physical properties of the resin composite system. Pre-reacted glass ionomer particles thus provide giomer composites with the potential to attain physical and aesthetic properties comparable to conventional composites as well as a simultaneous ability to release fluoride complexes to marginal and contacting tooth surfaces[47]

The introduction of zirconium oxide as a metal free, “ALL” ceramic option opened a new horizon for restorative dentistry with unlimited possibilities and virtually no limitations.[48]

Zirconium oxide was alluring due to its good mechanical properties, aesthetics and low plaque accumulation. It was introduced by Martin Heinrich Klaproth in 1789. But it took almost two centuries to decode this material in a way in which it can be used for medical and dental purpose. Gradually, zirconium oxide was found to be non-cytotoxic, insoluble in water and had no potential for bacterial adhesion. In addition, it had radiopaque properties and exhibited low corrosion. Due to such unique properties, zirconium oxide was first used for medical purpose in 1969 as a ceramic biomaterial for total hip replacements and later on in 1990, zirconia was popularized in dentistry as endodontic posts, later on as implant abutments and as hard framework cores for crowns and fixed partial dentures.

Recently in the year 2014, because of the high strength and esthetic appearance, Zirconia (ZrO_2) was infused in GIC (ZIRCONOMER), in an attempt to address all the issues that have plagued the conventional glass ionomer so far. Because of its high strength it is also called white amalgam.

Studies by **Eichmiller FC et al (1998)[49], Cooley Robert L et al(1990)[50]**, **Perrin Claudie et al(1994)[51]** emphasized that fluoride containing materials release fluoride in an initial burst and then reduce exponentially to a much lower steady state level of release which is reached after few days for most materials, so to check whether the fluoridated dentifrices were able to recharge the fluoride releasing restorative materials and reduced the rate of fluoride ion release by which fluoride ion concentration reached the steady state from the initial high burst.

With this in mind, this current study was designed in vitro, with the aim to evaluate and compare the fluoride recharge of fluoride releasing dental materials i.e GC Fujitype IX, Beautifill II LS,Zirconomer Improved and GC Fuji Plus.

Sample size for the study was 40 in numberand equally divided into two groups after confirming statistical validity of the study.Similar study was done by **Itota et al(2004)[16]** who had taken forty samples and divided into sub groupsto evaluate fluoride release and recharge in giomer, compomer and resin composite- Reactmer paste, Dyract AP and Xeno CF.

Each restorative material was divided into two groups,One group to evaluate fluoride release and other group to evaluate fluoride release after recharge using fluoridated dentifrice. Similar study was done by **Fabianagouveia Rolim(2019)[37]**to evaluate fluoride release and recharge potential of conventional glass ionomer cements and composite resins by fluoridated dentifrices.

In the present study,instead of artificial saliva deionized water was used as storage medium as it is devoid of any ions, doesn't react with the ions of restorative materials. Thus, the fluoride ionpresent in the deionized water is the same ion which is leached out from the restorative materials. Reports from the studies of **Robertella Francis (1999)**[48] suggest that , there are certain variations seen in natural saliva and technical difficulities associated with the use of artificial saliva.So deionized water was used in this study to ensure that fluoride releasewould be unaffected by these variables.Also,similiar in vitro study was done by **Sayan Dasgupta(2018)[33]**by evaluating fluoride release and recharge of GP IX Extra ,EQUIA Forte Fil, Beautifil Bulk, Dyract XP,Tetric N-Ceram .In this study too storage media was deionized water.

Pellets of each material were kept in different containers to avoid any physical and chemical contamination of the restorative material.All the materials were evaluated for their recharging capabilities with fluoride ions,within 24 hours and then after 7 days, 15 days using spectrophotometer . Spectrophotometer is a highly sensitive fluoride ion digital analyzer. It measures thefluoride ion with the help of infrared rays and appropriate sensors, and is not as techniquesensitive as fluoride ion electrode used in other studies.[53,54,55]**Jaidka (2012)[6]**did a similar in vitro study to evaluate recharge of fluoride releasing restorative materials by fluoridated dentifrices.In this study,fluoride evaluation was done by spectrophotometer.

The data was statistically analysed using ONE WAY-ANOVA and TUKEY’S test for evaluation of fluoride release of GIC type IX, Zirconomer Improved and ,Fuji Plus and Beautifil II LS.

When mean fluoride release was evaluated, it was found that Zirconomer Improved had the highest fluoride release among all. The rapid elution pattern of fluoride by Zirconomer may be attributed to the finely controlled micronization of the glass-ionomer particles. It is in conjunction with results reported by various studies that smaller glass particles provide a larger surface area, which increase the acid-base reactivity, and hence, have increased capacity to release fluoride from the powder more rapidly, thereby increasing the fluoride release of the materials[57,58,59]A similar study was conducted by**Paul et al[56]** who compared fluoride release and re-release of novel restorative material Cention N and Zirconomer Improved and noted that Zirconomer was more efficient in initial fluoride release and fluoride re-release after recharging.Anothersimilar study was done by**Virmani** et al[4] who compared the amount of fluoride released from zirconia-reinforced GIC ,Ketac™ Molar and packable posterior glass-ionomer restorative material (GC Fuji IX GP).In this study the maximum amount of fluoride release, observed by Ketac molar followed by Zirconomer improved and then followed by Fuji IX.

Fluoride release of Fuji Plus was comparatively more than GC Type IX .In RMGIC Acid-based reactions are slowed down by resin component,which makes the ionic matrix less mature and capable of releasing more fluoride compared with a conventional material of the same age. The HEMA present in resin modified glass ionomers slowly absorbs water to allow for the diffusion of fluoride ions. Thus fluoride is released gradually, thereby explaining the higher long-term release when compared to the conventional glass-ionomer cement.Similiar result was obtained in a study which was done by **Selinomovi dragas et al (2017)[60].**This study compared fluoride release of conventional glass ionomer cement and resin modified glass ionomer cement and concluded that resin modified GIC exhibited more fluoride release than conventional one.

GC Type IX showed less fluoride release than Zirconomer Improved and GC Fuji Plus and more compared to Beautifil II LS. Fluoride release from GIC occurs by surface loss,diffusion through pores and cracks,bulk diffusion.Slower fluoride release from GIC might be because of slower dissolution of glass particles through the pores. **Soumya et al(2021)[61]**had done similar study to compare fluoride release of Zirconomer Improved,Resin modified GIC and GIC in which study concluded that fluoride release is more in Zirconomer Improved followed by RMGIC and GIC**.**

Beautifil II LS showed statistically least amounts of controlled fluoride release in this study. Beautifil II LS contains surface prereacted glass ionomer (S-PRG) as a fluoride component. The fluoride glass within Beautifil has little or no glass ionomer matrix phase,thus there is non significant acid base reaction,which is important in the mechanism of fluoride release. Another explanation for difference in fluoride release between GIC and resin composite like (compomers and giomers) is that, these materials have added resin contents compared to GICs, the barrier through which water and fluoride to diffuse also increases, in addition to their filler solubility differences.[20] **Sayed Mostafa (2009)[62]** has done an invitro study on fluoride release from fluoride-containing materials- four glass ionomer cements (Fuji IX, Fuji VII, Fuji IX Extra and Fuji II LC), a compomer (Dyract Extra) and a giomer (Beautifil) .According to this study,Beautifil II LS releases least fluoride.Another study was done by **S M Abdul Quader(2012)[24]**.The study evaluated fluoride release of glass ionomers,compomer and giomer.The result showed that fluoride release capability of giomer is very less compared to glass ionomer cement.

Conclusion:-

Within the limitation of this invitro study, the evaluation and comparison of fluoride recharge of fluoride releasing dental materials by fluoridated dentifrices were done and following conclusions were drawn:-

1. All restorative materials used in the study showed a fluoride recharging capability when brushed with fluoridated dentifrices.
2. All materials exhibited a large initial release followed by a gradual decrease in fluoride ion concentration inspite of being brushed with fluoride containing dentifricesregularly.
3. Initial fluoride release was found to be maximum and then decreased which could notbe restored to the initial level even after brushing with fluoridated dentifrices regularly.
4. The mean fluoride release was maximum in Zirconomer Improved, followed by GC Fuji Plus ,then by GC Fuji Type IX and by Beautifil II LS.

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