ORIGINAL RESEARCH PAPER

Volume-7 | Issue-7 | July-2018 | PRINT ISSN No 2277 - 8179

INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

# COMPARISON OF AMOUNT OF FLUORIDE RELEASE FROM THREE DIFFERENT GLASS IONOMER CEMENTS- A SYSTEMATIC REVIEW.

Dental science

**Aditi S. Shere*** Post graduate student, Dr. D. Y. Patil Vidyapeeth`s, Dr. D. Y. Patil Dental college, Pimpri. *Corresponding Author

**Vishwas Patil** Reader and P G Guide, Dr. D. Y. Patil Vidyapeeth`s, Dr. D. Y. Patil Dental college, Pimpri.

**Anath Kamath** Reader and P G Guide, Dr. D. Y. Patil Vidyapeeth`s, Dr. D. Y. Patil Dental college, Pimpri.

## ABSTRACT

**OBJECTIVE:** To check amount of fluoride release from different glass ionomer cements.
**DATA SOURCES:** Internet source of evidence were the national library of Medicine and the Cochrane Central Register of Controlled Trials, Google Scholar, Google, manual search using DPU college library resources. Articles published between 1st January 2008 and 31st august 2017.
**RESULTS:** Preliminary screening consisted total of 1365, 14 articles were selected. Only 12 with full text were selected.
**CONCLUSION:** Fluoride release was evaluated in all three GIC materials, viz. Conventional Glass ionomer cement, RM glass ionomer cement, Nano filled Glass Ionomer Cement. RM Glass Ionomer Cements has shown higher fluoride release than Conventional GIC and Nano filled Glass Ionomer Cement. Nano filled Glass Ionomer Cement released less but steady fluoride as compared to other materials.

## KEYWORDS

Glass Ionomer Cements, Fluoride Release, Resin Modified Glass Inomer Cement, Nanofilled Resin Modified Glass Inomer Cement.

## INTRODUCTION:

Caries prevention and eradication has been greatest challenge for the dentist. The prime objective for prevention is to induce changes in dental tissue that may resist the initiation of carious process itself. Caries process is characterized by demineralization of the inorganic portion and destruction of organic substance of the hard dental tissue which often leads to cavitation.

Demineralization is a result of fall in pH in oral cavity. Continuous demineralization results in loss of tooth structure. Its progression or control depends on the balance between pathological and protective factors, and the best strategy for caries management is focused on methods of improving the remineralization process.

The old concept that fluoride strengthens the teeth, making them more resistant to caries, is still prevalent. Fluoride interferes with the caries process, reducing demineralization and enhancing remineralization of enamel and dentin. [1,2]

This physio-chemical mechanism occurs every time sugar is ingested and the pH falls in biofilm fluid and if fluoride is present in the oral fluids enhances the natural phenomenon of remineralization. As a consequence, the progression of caries lesions is slowed down.[2] The effect of fluoride is on the caries process, and not the cause of caries lesions reduction.[3]

Fluoride-releasing materials should also be considered a way to maintain fluoride constantly in the mouth. For instance, glass ionomer cements, in addition to releasing fluoride for a long time, can also be recharged with the ion from other sources, such as fluoride dentifrice.[4] Glass ionomer cements GICs were introduced by Wilson and Kent in 1970s.[5] These materials release a variety of ionic constituents from the glass, including fluoride.[6]

Positive characteristics of glass ionomer cements include chemical adhesion in the presence of moisture, biocompatibility, fluoride release, rechargeability, and less shrinkage than resins upon setting with no free monomer being released. Negative characteristics of this material include early moisture sensitivity, poor abrasion resistance, and only average aesthetics.[7]

The initial fluoride release from glass ionomer is due to an acid-base reaction, with the amount of fluoride released proportional to the concentration of fluoride in the material.[8] This is responsible for the phenomenon of "burst effect," wherein high amounts of fluoride are released during the first two days. Fluoride release declines rapidly during the first week and stabilizes after three to four weeks.[9]

Newer highly filled glass ionomers are very useful as long-term temporary restorations. As well as featuring a high powder-liquid ratio, these materials are packable and quick-setting. Various studies are reported regarding fluoride release[10, 11] Remineralisation[12] and caries inhibition.[13]

Resin modified glass ionomer cements address many of the limitations of the conventional glass ionomer cements. This cement was introduce by Antonucci, Mc Kinney and S B Mitra. The first commercially product was Vitrebond in 1989. Defined as Hybrid cement that sets partly by acid base reaction and partly by polymerization reaction. Resin modified glass ionomer cement materials introduce a polymerization component to the basic glass ionomer cement setting chemistry and do not require immediate surface protection to maintain optimum water content for gel formation, they are less sensitive to desiccation and hydration, have improved aesthetics, greater tensile strength and fracture toughness than the conventional glass ionomer cement materials.

Resin-modified glass-ionomers were mostly found to have a potential for releasing fluoride in equivalent amounts as conventional cements,[14] but may be affected not only by the formation of complex fluoride compounds and their interaction with polyacrylic acid, but also by the type and amount of resin used for the photochemical polymerization reaction.[15,16,]

In contrast to the conventional and resin-modified glass ionomers, polyacid-modified composites are mostly shown to have no initial fluoride 'burst' effect, [17, 9, 18, 19] but levels of fluoride release remain relatively constant over time.[9,20]

Recently, a new material, a nanoionomer, was introduced. It was developed by 3M ESPE– Ketac N100. Its manufacturer has indicated that the nano-ionomer has a higher fluoride release. The nano-ionomer is based on acrylic and itaconic acid copolymers necessary for the glass-ionomer reaction with fluoroaluminosilicate (FAS) glass and water. Resin modified GICs also have a polymer resin component which usually sets by a self-activated (chemically cured) or light-activated polymerization reaction. These "hybrid" materials have been developed to combine the mechanical properties of a resin composite with the anti-carious potential of GICs. The origin of this glass ionomer cement is the inclusion of nano-fillers, which constitute up to two-thirds of the filler content. The presence of nano-sized glass particles and clusters of nanosilica particles in this material has been claimed to improve its physical properties. Nano-ionomer has a structural morphology that is a hybrid of resin-modified glass ionomer and nano-filled resin composite. The manufacturer claims that the acid reactive glass fillers and methacrylate functional nanofillers of the nanoionomer are smaller than those of conventional resin modified glass-ionomer cement. It is possible that the increased surface area to volume of the nano-sized filler has the capacity to release fluoride in the powder more quickly, increasing the fluoride release of the material.[21]

At high concentrations, fluoride has been thought to reduce the rate of demineralization, enhance the remineralization process, inhibit the growth, and attachment of bacteria on tooth surfaces and impede the formation of a complex bacteria biofilm. However, to date, it has not been established whether the amounts of fluoride released from glass ionomer cements is sufficient to impede dental caries

Several comparative studies were published concerning fluoride release from conventional glass ionomer cement, resin modified glass ionomer cement, nano filled glass ionomer cement.

The aim of this systematic review is to compare of amount of fluoride release from three different Glass Ionomer Cements ie conventional glass ionomer cement, resin modified glass ionomer cement, nano filled glass ionomer cement.

## LITERATURE SURVEY:

## METHODS:

Internet sources of evidence were used in the search of appropriate papers satisfying the study purpose: the National Library of Medicine (MEDLINE PubMed) and the Cochrane trial register of Controlled Trials (CENTAL), Google Scholar, Google, Clinical trial registry and manual search using DPU college library resources. All cross reference lists of the selected studies were screened for additional papers that could meet the eligibility criteria of the study. The databases were searched up to and including Aug 2017 using search strategy. Keywords used for search strategy were as follow Glass Ionomer Cements, Fluoride release, Resin Modified Glass Inomer Cement, Nanofilled Resin Modified Glass Inomer Cement.

## INCLUSION CRITERIA

1. All articles in English
2. Articles published between 2008 -2017
3. Studies evaluating fluoride release by fluoride ions selective electrode.
4. Simulated oral environment condition.
5. Articles which include any two materials for comparison will be included.
6. Any of these 3 material compared with other material will be included.

## EXCLUSION CRITERIA:

1. Reviews, abstracts & letter to editor are excluded.
2. Studies that did not have inclusion criteria.
3. Articles published in languages other than English.

## PICO FORMAT

| | |
|---|---|
| *P* | Product |
| *I* | Conventional Glass Ionomer Cement |
| *C* | Resin Modified Glass Ionomer Cement, Nanofilled Glass Ionomer Cement |
| *O* | Fluoride release |

| *Study ID* | *Year* | *Author* | *Intervention* | *Comparison* | *Duration of study* | *Sample size* | *Out come* | *Follow UP* | *Results* | *Remarks* |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2011 | P Neelakantan et al | conventional GIC | conventinal GIC, RMGIC | 28 days | 10 | fluoride release | 28 days | Nanoionomer | initally Conventional GIC release more amout of fluoride while nanoionomer release more at 7th day of 1st week |
| 2 | 2011 | Paschoal MA | conventional GIC | nanofilled RMGIC, RMGIC, CONVENTIONAL | 15 days | 6 | fluoride release | 15 days | nanofilled GIC ,RMGIC nanofilled GIC ,RMGIC | fluoride release profile from nanofilled RMGIC was comparable with RMGIC |
| 3 | 2011 | Basso G. R | conventional GIC | conventinal GIC, RMGIC | 28 days | 9 | fluoride release | 28 days | RMGIC | fluoride release occurred in 1st 24 hours. |
| 4 | 2012 | Tiwari S and Nandlal B | conventional GIC | HA GIC , Cnventional GIC | 21 days | 20 | fluoride release | 21 days | Cnventional GIC Cnventional GIC | mean fluoride release from Both group from 1 - 21 days |
| 5 | 2013 | sumitha Upadhyay | conventional GIC | Nanofilled RMGIC, RMGIC | 30 days | 10 | fluoride release | 30 days | RMGIC | nanofilled RMGIC showed steady fluoride release |
| 6 | 2013 | Dragas M S et al | conventional GIC | conventinal GIC, RMGIC | 24 hours | | fluoride release | 24 hours | RMGIC | RMGIC showed fluoride release when comparaed to conventional GIC |
| 7 | 2015 | Cabral M F etal | conventional GIC | RMGIC (Vitremer,Vitro Fil LC, Resiglass | 15 days | 6 | fluoride release | 15 days | RMGIC | GIC shown more fluoride release compared to other. There is wide variations among the material interms of amount of fluoride release. |
| 8 | 2015 | Bansal R and bansal T | conventional GIC | conventinal GIC, RMGIC, compomer | 15 days | 15 | fluoride release | 15 days | conventinal GIC | conventional GIC> RMGIC> GIOMER, compomer |
| 9 | 2016 | Tiwari S et al | conventional GIC | GIC, Compomer, Zirconia RMGIC | 21 days | 20 | fluoride release | 21 days | zircomer | highest amount of fluoride release from zircomer but gradually decreases till 21st day. |
| 10 | 2016 | Saxena S et al | conventional GIC | zircomer, GIC | 30 days | 15 | fluoride release | 30 days | zircomer | F release from GIC was increased from day day 1 to day 7 but decreased from day 15 and 30. similarly with zircomer but released more fluoride than conventional GIC |
| 11 | 2017 | Senthil K. R et al | conventional GIC | Nanochitosan modified glass ionomer cement, Conventional GIC | 7 days | 15 | fluoride release | 7 days | Nanochitosan modified glass ionomer cement | incorporation of Nanochitosan modified glass ionomer cement shown fluoride ion release comparaed to Conventional GIC |
| 12 | 2012 | Zeynep OKTE et al | conventional GIC | RMGIC, Polyacid modified GIC, fluoride releasing composite resin | 21 days | 20 | fluoride release | 21 days | RMGIC | RMGIC showed fluoride release when comparaed to conventional GIC, Polyacid modified GIC, fluoride releasing composite resin |

**STUDY SELECTION:**
Preliminary screening consisted of 1368 articles out of which 14 were selected.

The papers were screened independently by two reviewers AD, VP. At first the papers were screened by title and abstract. As a second step, full text papers were obtained when they fulfilled the criteria of the study aim. Any disagreement between the two reviewers was resolved after additional discussion. For full text screening, the following criteria were taken into consideration comparative and original research was included. Only 12 with full text were selected.

**DATA COLLECTION PROCESS**
A standard pilot form in excel sheet was initially used and then all those headings not applicable for review were removed. Data extraction was done for one article and this form was reviewed by an expert and finalized. This was followed by data extraction for all the articles.

**DISCUSSION:** Dental caries is one of the most common preventable diseases which are recognized as the primary cause of oral pain and tooth loss. It is a major public health oral disease which hinders the achievement and maintenance of oral health in all age groups.

Dental caries refers to the localised destruction of susceptible dental hard tissues by acidic by-products from the bacterial fermentation of dietary carbohydrates. This hampers fall in pH leading to demineralisation and remineralisation frequently during the day. Over time, this process leads to either caries lesions or the repair and reversal of a lesion.

Fluoride can be delivered either topically or systemically in order to protect teeth and prevent tooth decay and cavities. Fluoride therapy ranges from at home therapies to professional administered to community based.

Delivery system for fluoride for professional application include prophylactic pastes, mouthwash solution, and pit and fissure sealant, and for unsupervised home use include fluoride dentrifices and rinses. The addition of fluoride to restorative material is usefull in releasing low fluoride for longer duration to the teeth.

Fluoride treatment is most effective when used as a preventive measure. At the earliest stages of the caries process, before a cavity forms, fluoride can reverse small carious lesions. Once a cavity has developed, fluoride can no longer arrest the caries process, but can only slow it down.

Trace levels of fluoride in biological media are determined primarily by potentiometric (ion selective electrode [ISE]) and gas chromatographic (GC) methods. Colorimetric methods are also available, but are more time consuming and lack the sensitivity of the other methods (Kakabadse et al. 1971; Venkateswarlu et al. 1971). There is extensive literature on the ISE methodology because it is the most frequently used method for fluoride measurement in biological media

Fluoride release from restorative materials is measured by ion selective electrode method. An ion selective electrode also known as a specific ion electrode is a transducer or sensor that converts the activity of a specific ion dissolved in a solution into an electrical potential, which can be measured by a voltmeter or pH meter. An ideal principle of ion selective electrode consists of a thin membrane across which only the intended ion can be transported. The transport of ions from a high concentration to a low one through a selective binding with some sites within the membrane creates a potential difference. Thermo Scientific Orion fluoride electrodes feature high quality lanthanum fluoride pellet sensors. Analyze free fluoride ions in aqueous solutions reliably at low limits of detection. Measurements are quick, simple, accurate and economical.

The initial fluoride release from glass ionomer is due to an acid-base reaction, with the amount of fluoride released proportional to the concentration of fluoride in the material.[24] This is responsible for the phenomenon of "burst effect," wherein high amounts of fluoride are released during the first two days. Fluoride release declines rapidly during the first week and stabilizes after three to four weeks.[9]

Papagiannoulis et al in 2002 observed that fluoride release from GICs occurs by means of three mechanism; surface loss, diffusion through pores, and bulk diffusion.

Upadhay et al in 2013 reported that GIC is a complex process and the released amount depends on various factors.

The release fluoride from dental materials is governed by various intrinsic and extrinsic factors. The intrinsic factors include composition, powder/liquid ratio, mixing time, temperature, specimen geometry, permeability, surface treatment and finishing. Extrinsic factors include type of storage medium, experimental design and analytical methods.[22] These extrinsic factors make difficulty any comparison between our data and those from other studies.

Influence of storage media on fluoride release from materials is more in deionized water as compared artifial saliva, due to deionized water cation. (El Mallakh BF).

Historically, most in vitro fluoride release studies have been performed using a static immersion medium, most commonly distilled or deionized water or artificial saliva or pH cycling system (demineralization remineralization solutions). Basso et al suggested that use of storage media that simulate the oral environment should be considered. Basso et in 2011evaluated and compared fluoride release from conventional GIC and RMGIC, use of reverse osmosis water were used as storage media. Okte et al experimented fluoride release from RMGIC and conventional GIC which was immersed in artificial saliva and double distilled water. In his study fluoride release was observed more in double distilled water than artificial saliva, indicating that fluoride release is significantly influenced by the ionic strength and composition of artificial saliva. Costa et al in his study used demineralizing solution as storage media representing oral conditions An analysis of these findings reveals that pH and ionic saturation from an immersion medium can influence the quantity of fluoride released. Indeed, for conventional and resin-modified GICs, the highest fluoride release is found in acidic and de-re solutions.

Besides the pH, the type of acid found in immersion solutions has an important effect on cement degradation. McKenzie et al. observed that solutions containing carboxylic acids have shown a greater degradation potential over ionomer cements than solutions containing phosphoric acid. The degradation of ionomer cements is directly related to fluoride release.[25]

The daily use of fluoride incorporated into dentifrices and solutions could also affect the amount of fluoride uptake and release from the materials. Moreover, when pH decreases during cariogenic and erosive challenges, it is suggested that the fluoride release from the materials increases. The fluoride release from the restorative materials could affect the carious process through of reduction of demineralization and increase the remineralization during and after the cariogenic challenges [28]. Nevertheless, the amount of fluoride necessary for an effective anticariogenic effect is still unknown.

Incorporating fluoride, a remineralizing agent in a restorative material, definitely reduces the occurrence of secondary caries. Fluoride released from restorative materials has an effective zone of about 1 mm from the margin of glass ionomer restorations [25]. Release of fluoride from restorative materials also maintains the fluoride level in the oral fluid. After placement of glass-ionomer restorations, salivary fluoride concentration is approximately 0.3 ppm immediately after and remains up to 0.04 ppm after 1 year. Capability of glass-ionomer cements to act as a fluoride ion reservoir presents an important advantage in the process of prevention of secondary caries around restorative margins as well as surrounding surfaces .

Fluoride release by GICs and RMGICs is an important property of those materials and plays a major role in its selection for specific clinical application . It seems that fluoride ions released from GICs act in a dose-dependant manner. *In vitro*, at relatively high concentration, fluoride acts as an enzyme inhibitor. *In vivo*, eliminates microorganisms, those which remains in the cavity after preparation, and reinforces demineralized enamel and dentin.

**CONCLUSION:**
On the basis of results obtained from the included articles it can be concluded that cumulative fluoride release at the end of the study period in nano-ionomer GIC was significantly higher than the conventional glass ionomer cement and resin-modified GIC. Initially the fluoride release of resin modified glass ionomer cemnt, conventional glass ionomer cement was more than the Nanofilled glass

ionomer cement. Nanofilled of resin modified glass ionomer cement released less but steady fluoride as compared to resin modified glass ionomer cement, conventional glass ionomer cement.

**FUTURE SCOPE:**

Large numbers of studies are required to be carried out for in vivo and invitro studies. Comparative studies are required between in in-vivo and in-vitro is with same followup and materials. More precise studied needs to be carried out considering proper study protocol and unique assessment scale to score the success and failure.

## References


[1] Fejerskov O, Cury JA, Tenuta LMA, Marinho V. Fluorides incaries control. In: Fejerskov O, Kidd E, editors. Dental caries:the disease and its clinical management. third ed. Oxford:Wiley Blackwell; 2015. p. 24 76.

[2] Cury JA, Tenuta LM. Enamel remineralization: controlling the caries disease or treating early caries lesions? Braz OralRes 2009;23(Suppl 1):2 30.

[3] Tenuta LM, Cury JA. Fluoride: its role in dentistry. Braz OralRes 2010;24(Suppl 1): 17.

[4] Vieira AR, de Souza IP, Modesto A. Fluoride uptake andrelease by composites and glass ionomers in a high carieschallenge situation. Am J Dent 1999;12:1 8.

[5] Sashibhushan KK, Basappa N, Subba Reddy VV. Comparison of antimicrobial activity of three fluoride and zinc releasing commercial glass ionomer cements on strainsnof mutans streptococci: an in vitro study. J Indian SocPedodPrev Dent. 2008; 26:S56-61.

[6] Verbeeck RM, De Maeyer EA, Marks LA, De Moor RJ, De Witte AM, Trimpeneers LM. Fluoride release process of (resin-modified) glass-ionomer cements versus (polyacid-modified) composite resins. Biomaterials 1998;19:50 19.

[7] F. M. Burke, N. J. Ray and R. J. McConnell. Fluoride-containing restorative Materials. International Dental Journal (2006) 56, 33-43

[8] Wiegand, Annette et al. Review on fluoride-releasing restorative materials—Fluoride release and uptake characteristics, antibacterial activity and influence on caries formation. Dental Materials , Volume 23 , Issue 3 , 343 – 362

[9] Yap AU, Tham SY, Zhu LY, Lee HK. Short-term fluoride release from various aesthetic restorative materials. Oper Dent 2002;27:259–65.

[10] Khouw-Liu VH, Anstice HM, Pearson G J. An in vitro investigation of a poly(vinyl phosphonic acid) based cement with four conventional glass-ionomer cements. Part 1: Flexural strength and fluoride release. J Dent 1999 27: 351-357.

[11] Rothwell M, Anstice HM, Pearson GJ. The uptake and release of fluoride by ion-leaching cements after exposure to toothpaste. J Dent 1998 26: 591-597.

[12] Jang KT, Garcia-Godoy F, Donly KJ et al. Remineralizing effects of glass ionomer restorations on adjacent interproximal caries. JDent Child 2001 68: 125-128, 142.

[13] Smales RJ, Gao W. In vitro caries inhibition at the enamel margins of glass ionomer restoratives developed for the ART approach. J Dent 2000 28: 249-256..

[14] Robertello FJ, Coffey JP, Lynde TA, King P. Fluoride release of glass ionomer-based luting cements in vitro. J Prosthet Dent 1999;82:172–6.

[15] Musa A, Pearson GJ, Gelbier M. In vitro investigation of fluoride ion release from four resin-modified glasspolyalkenoate cements. Biomaterials 1996;17: 1019–23.

[16] Momoi Y, McCabe JF. Fluoride release from light-activated glass ionomer restorative cements. Dent Mater 1993;9:151–4.

[17] Attar N, Turgut MD. Fluoride release and uptake capacities of fluoride-releasing restorative materials. Oper Dent 2003;28:395–402.

[18] Yip HK, Smales RJ. Fluoride release from a polyacid-modified resin composite and 3 resin-modified glass-ionomer materials. Quintessence Int 2000;31: 261–6.

[19] Forsten L. Fluoride release and uptake by glass-ionomers and related materials and its clinical effect. Biomaterials 1998;19:503–8

[20] Shaw AJ, Carrick T, McCabe JF. Fluoride release from glass-ionomer and compomer restorative materials: 6-month data. J Dent 1998;26:355–9.

[21] P Neelakanta, S John, S Anand , N Sureshbabu, C Subbarao Fluoride Release From a New Glass-ionomer Cement. perative Dentistry, 2011, 36-1, 80-85.

[22] Horsted-Bindslev P. Fluoride release from alternative restorative material. J dent 1994;22Suppl1:S17-S20.

[23] Gandolfi MG, Chersoni S, Aquaviva GL, Piana G, Prati C, Mongiorgi R. fluoride relase and absorbtion at different pH from glass ionomer cement. Dent Mater 2006;22:441-449.

[24] Attar N, Onen A. fluoride release and uptake characteristic of aesthetic restorative material. J Oral Rehabil 2002;29:791-798.

[25] Tantbirojn D, Douglas WH, Versluis A. inhibitive effect of resin odified glass ionomer cement on remote artificial caries. Caries Res. 1997:31(4):275-80.