

Evaluating fluoride release from different restorative materials at various time intervals - An in vitro study

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Abstract

Context: Glass ionomer cement is very popular in clinical practice due to their antibacterial and cariostatic properties, which is totally dependent on the amount of fluoride release and uptake by dentine. Short term and long-term fluoride uptake by dentine from commercially available a novel restorative material, ACTIVA Bio Active-Restorative and compomer is of clinical interest.

Aim: To investigate the fluoride release from three different fluoride releasing materials at different time intervals.

Materials and Method: A total of 30 non-cariou premolar teeth will be included in this study. Teeth will be divided into three equal main groups (n= 10) according to the type of restorative material. The first group; GC Gold Label universal restorative material, the second group; Compomer restorative material and the third group, ACTIVA Bio Active composite material.

Each sample will be immersed in 5 ml of artificial saliva and will be evaluated for its fluoride release at 1,7,14 and 21 days by using microanalytical technique.

Statistical Analysis: One-way ANOVA test will be used to statistically analyse the data.

Results: The statistical analysis of fluoride release (ppm) of different restorative materials at different time intervals revealed that; the difference in fluoride release was statistically significant as indicated by Post Hoc (Tukey) test. A statistically significant difference among the groups for fluoride release was seen at all time intervals (Group I > Group II > Group III)

Conclusion: CGIC was considered to be the material with the highest fluoride releasing potential, while ACTIVA showed the lowest fluoride releasing potential at each time interval. It was observed that Compomer showed a lower fluoride releasing potential than those of CGIC, a higher value than those of ACTIVA BIO COMPOSITE.

Keywords: Activa Bio Composite, Compomer, Ion-Specific Electrode

Introduction

Modifications in the field of dentistry is a pathway of progression and the resultant is the development of new techniques and methods for the best possible therapy for individuals. The modifications not only for the Techniques but for the biochemical and physical properties of different materials is equally significant. With increasing advancements and research in the field of biochemical industry frequent alterations for betterment of already known material has made it possible to increase properties of materials make it render its performance at its best. One such widely researched and modified property of any restorative material is its capability of releasing fluoride. Hydroxyapatite crystals after combining with fluoride become fluorapatite which is

considered more stable and resistance material for tooth surface protection against cavitation. Therefore, Fluoride-containing restorative materials gained great attention over the last two decades as a means of protection against recurrent caries. It has been effective in inhibition of demineralization process while favouring the remineralization process by increasing enamel resistance to dissolution by acid produced by bacteria.¹ Different restorative materials available commercially that releases fluoride, comparatively amongst all the fluoride - releasing restorative materials, conventional glass ionomer cement (GIC) exhibits the high efficacy in resisting secondary caries formation around restorations.² However, they are inferior in comparison to composite resins because of high moisture sensitivity, low initial mechanical properties, and inferior translucency.³ To overcome the shortcomings of GICs while maintaining their clinical advantage in caries inhibition, hybrid materials that purportedly combine the benefits of glass ionomers and composite resins were developed.⁴

Aim and objective

This in vitro study aimed to assess and compare the fluoride releasing potential from three different restorative materials at different time intervals.

Material and method

30 extracted human permanent premolar teeth without any previous restoration or fractures, free of cracks and developmental disturbances, free of stains and normal anatomical structure were selected. Following the cavity preparation guidelines for composite (3 mm wide, 2 mm long, and 1 mm deep) standard non-beveled buccal class V cavities were prepared. In each group, the prepared cavity was restored with its assigned restorative material. Followed by acid etching and bonding agent application. Curing was done (Fig 1). The teeth were divided into 3 equal groups (n= 10) and grouped as Group A (Glass

ionomer cement), Group B (Dyract flow Compomer), Group C (Activa bio composite material) (Fig 2). All the samples were than stored in 10ml of artificial saliva at 37°C for 24 hours. After 24 hours incubation, the plastic containers were thoroughly shaken and the first fluoride concentration measurement of each specimen was performed. To determine the amount of fluoride release, 1 ml of TISAB III was mixed in 10 ml of sample solution. Then, teeth were removed, washed with 5-ml of distilled water, and transferred to a new container, containing 10-ml of fresh artificial saliva. Cumulative fluoride concentration in artificial saliva was measured on the 1st, 7th, 14th, and 21st day. Fluoride concentration was measured using micro analytical technique with an inverted fluoride ion-selective electrode.

Result

The statistical analysis of fluoride release (ppm) of different restorative materials at different time intervals revealed that; the difference in fluoride release was statistically significant as indicated by Post Hoc (Tukey) test. A statistically significant difference among the groups for fluoride release was seen at all time intervals (Group I > Group II > Group III)

Group	Mean Fluoride Release in ppm After treatment (Mean ±S.D.)	F value	P value
Group A (GIC Group)	2.98± 1.43	38.99	0.000 (P<0.001) Very highly Significant
Group B (Compomer Group)	0.219±0.09		
Group C (Activa Bio composite)	0.085±0.04		

Table 1: Comparison of Mean Fluoride release among

Group A (GIC Group), Group B (Compomer Group) and Group C (Activa Bio composite) after 24 hours of restoration placement.

Group	Mean Fluoride Release in ppm After treatment (Mean ±S.D.)	F value	P value
Group A (GIC Group)	2.16± 0.787	62.42	0.000 (P<0.001) Very highly Significant
Group B (Compomer Group)	0.283± 0.11		
Group C (Activa Bio composite)	0.077± 0.04		

Table 2: Comparison of Mean Fluoride release among Group A (GIC Group), Group B (Compomer Group) and Group C (Activa Bio composite) after 7 days of restoration placement.

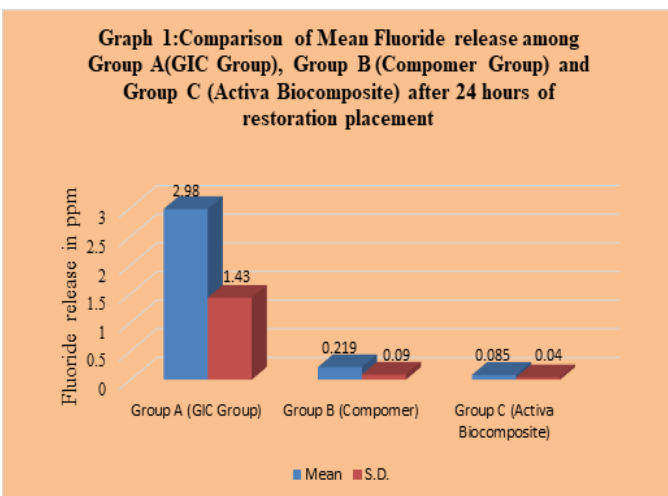
Group	Mean Fluoride Release in ppm After treatment (Mean ±S.D.)	F value	P value
Group A (GIC Group)	1.06±0.32	69.7	0.000 (P<0.001) Very highly Significant
Group B (Compomer Group)	0.284±0.13		
Group C (Activa Bio composite)	0.054±0.015		

Table 3: Comparison of Mean Fluoride release among Group A (GIC Group), Group B (Compomer Group) and Group C (Activa Bio composite) after 15 days of restoration placement.

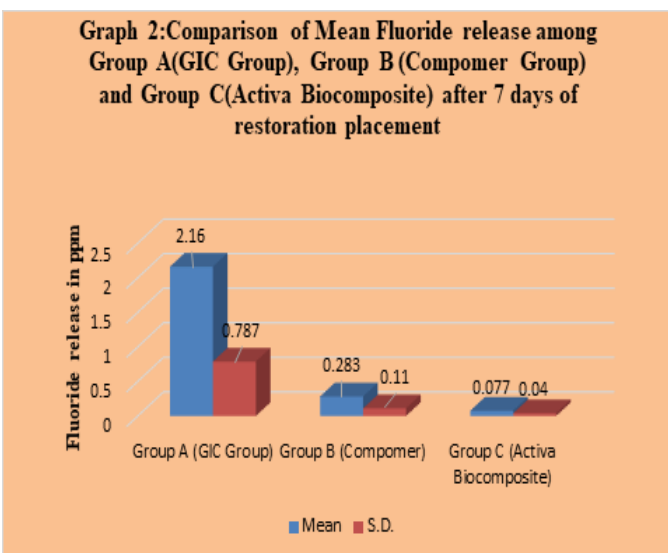
Table 4: Comparison of Mean Fluoride release among Group A (GIC Group), Group B (Compomer Group) and Group C after 21 days of restoration placement.

Group	Mean Fluoride Release in ppm After treatment (Mean ±S.D.)	F value	P value
Group A (GIC Group)	0.93± 0.28	80.54	0.000 (P<0.001) Very highly Significant
Group B (Compomer Group)	0.188± 0.08		
Group C (Activa Bio composite)	0.036± 0.01		

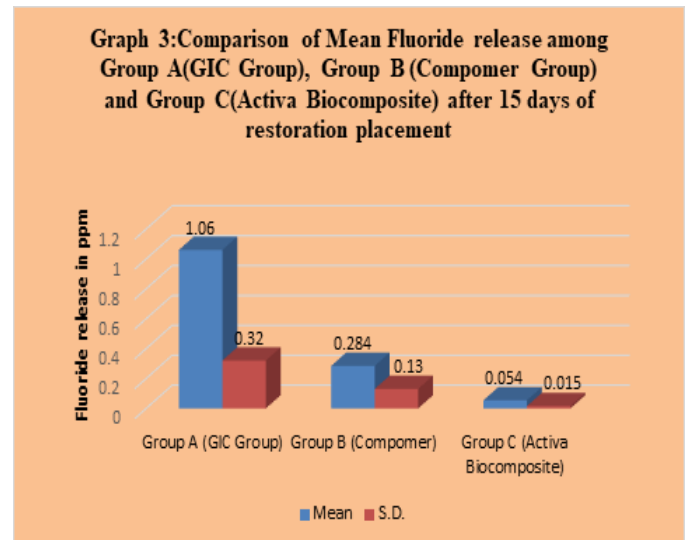
Graph 1:



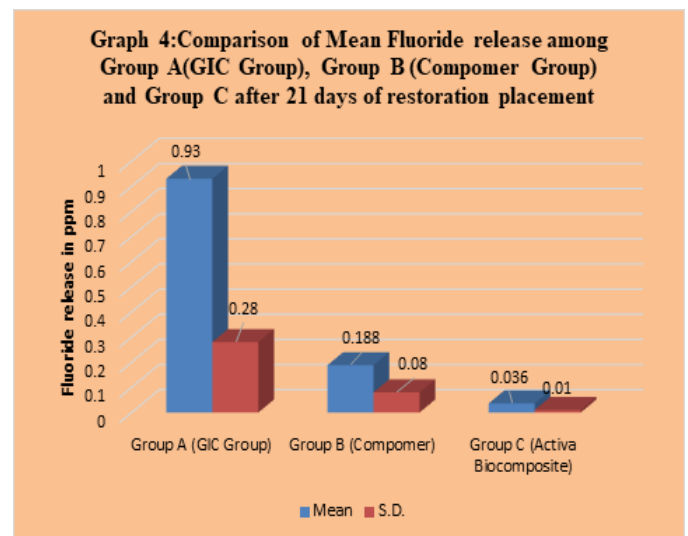
Graph 2:



Graph 3:



Graph 4:



Discussion

In the current study, Compomer and Activa Bio composite restorative material were selected as alternative restorative materials to overcome the short comings of the conventional GICs while maintaining their clinical advantage in caries inhibition. Artificial saliva with no fluoride content was used to avoid the presence of fluoride ions in natural saliva, which may act as a confounding factor. Ion-specific electrode with an iron analyzer was used in this study because it is simple, inexpensive and does not require the use of complex laboratory equipment.

All fluoride-releasing dental materials investigated in this study released the greatest amount of fluoride ions on the 1st-day.

The high level of fluoride release from GIC materials on day 1 was probably due to an initial “burst” of fluoride release from the glass particles. As Regards to compomer, our study agreed with Neela kantan et al [5] (2011) and Bansal and Bansal [6] in 2017, where their study showed that compomer had no initial fluoride “burst” effect but lower constant level of fluoride release than conventional GIC from the first day throughout the 21 days study period.

El Mallakh BF et al (1990) ⁷ in their study also showed that Glass ionomer cement release more fluoride in de-ionised water than artificial saliva, Ketac –Fil released 20% more fluoride in saliva than did Fuji –II, latter releasing 49 % more fluoride than Ketac – Fill in de-ionised water and conventional glass ionomer released more fluoride than did meta- reinforced ones in both media.

Nigam GA et al (2009)⁸ found significant variations in the amount of fluoride release from all the materials in different storage media. Glass ionomer cement released significantly higher amounts of fluoride ($p < 0.001$) in all storage media. The difference between composite resin and other materials was also very significant ($p < 0.001$) where composite resin released very less fluoride in all the media.

On contrary, study of Mousavinasab et al⁹ in 2009 showed that GICs released significantly less fluoride than compomer on the 1st week. Regarding the fluoride release of ACTIVA, it showed relatively high release after 24 hours which markedly declined over the 21 days.

According to Elbahrawy and Attia¹⁰, ACTIVA showed a relatively constant fluoride release for 28 days and a small amount of fluoride release and recharge.

According to the results of the present study the amount of initial fluoride release in descending order were Compomer followed by ACTIVA.

A possible limitation of the present study is that the dynamic nature of conditions found actually in the oral cavity such as salivary flow characteristics, presence of plaque, oral hygiene and dietary habits utilized by the patient which can lead to results that may be different from what have been proven in the current study. Thus further studies employing clinical trials are important.

Conclusion

Within the limits of this in vitro study, it could be concluded that the CGIC was considered to be the material with the highest fluoride releasing potential, while Activa showed the lowest fluoride releasing potential at each time interval. It was observed that Compomer showed a lower fluoride releasing potential than those of CGIC, a higher value than those of Activa bio composite.



Figure 1:



Figure 2:

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