A Comparative Evaluation of Fluoride Release from Three Different Fluoride Containing Restorative Materials: An In Vitro Study

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Abstract

Introduction: To compare the fluoride release from Conventional Glass Ionomer Cement (GIC), Resin Modified GIC (RMGIC), and Cention N. Recurrent caries is recorded to be the common cause of restorations failure in dental clinics.

Material and Methods: Forty-five disc-shaped specimens of three different restorative materials (Conventional GIC, RMGIC, and Cention) were made and divided into 3 groups (n=15). Fluoride release was evaluated at the end of Day 1, 7, 14 using ion-selective electrode. Intergroup and intra-group analysis was done using One-way ANOVA with a Post-hoc test. A P-value of <0.05 was considered statistically significant.

Results: The Fluoride release was highest from Conventional GIC followed by Resin modified GIC, Cention. The findings revealed that there was a significant difference in fluoride release with different materials and also at different days ($p<0.05$)

Conclusion: The initial fluoride release was highest from Conventional GIC followed by Resin Modified GIC and Cention.

Key Words: Cention, Fluorides, Glass Ionomer Cements, Selective ion electrode.

Introduction

Recurrent caries is recorded to be the common cause of restorations failure in dental clinics. Efforts in industrialized dental materials are continuing to formulate their compositions to decrease recurrent caries formation. Fluoride containing restorative materials gained great attention over the last two decades. Fluoride decreases caries activity by being a biocide and by decreasing the solubility of enamel and dentin through its integration into tooth tissue to form fluorapatite. Moreover, it has been revealed that fluoride aids to re-mineralize impaired tooth tissue after demineralization. [1, 2]

With time, newer and better materials for restoration have evolved, and recently "Alkasite" restorative material has been introduced. [3] Alkasite material-Cention is comparable to GIC and RMGIC because it has fluoride release and is also an aesthetic material; thus, it can be used in aesthetically concerned areas just like the latter materials. This material has relatively more translucency when compared to other glass-ionomer products, thus achieving better aesthetic properties. Moreover, it has better compressive strength than GIC and RMGIC. Therefore, Alkasite material has more diverse uses when compared to its counterparts. An extensive review of the literature yielded no documentation on the comparison of the amount of fluoride release from Alkasite material with Conventional GIC and RMGIC.

The aim of this study was to determine and compare the fluoride release of three different fluoride containing restorative materials (a conventional Glass Ionomer Cement, a Resin modified GIC, a Cention N).

Materials and Methods

The present study was conducted in Rama Dental College Hospital and Research Centre, Kanpur, India.

Materials

The restorative materials were mixed and were divided into the following groups: Group 1: Conventional GIC (GC Fuji II, GC America Corp., Alsip, IL, USA); Group 2: RMGIC (GC Fuji II LC, GC America Corp., Alsip, IL, USA); and Group 3: Cention N (Ivoclar Vivadent AG, Zurich, Switzerland).

Preparation of the cement discs

Fifteen test samples of each material were made in the form of round disc shape, 5mm in diameter and 3mm in thickness using stainless steel moulds, placed between two glass slabs. A thin layer of Vaseline was used to coat lateral surfaces of the mould to prevent material adhesion. The unwaxed dental floss was held in the centre of the mould. All restorative materials were mixed according to manufacturer's instructions and placed into moulds. The light curing materials were cured from top and bottom using a light source for 40 sec. After setting, the excess was removed using Bard Parker Blade. The specimens were removed from the mould and immersed in 20 ml of deionized water in air tight plastic bottles and stored in the incubator at 37 degree Celsius for 24 hrs.

Fluoride Release

The cumulative fluoride release measurement was made during 1st day, 7th day and 15th day using ion specific electrode.

Deionized water was then analysed for fluoride release using ion specific electrode. The samples were then removed from the bottle, washed with 1ml of double distilled water using a syringe, dried on absorbent paper and then restored in 20ml of fresh deionized water. This procedure was repeated for all the samples across different time intervals. The results attained were expressed as the quantity of fluoride released in parts per million (ppm).

Measurement of Fluoride Release

The amount of fluoride release was measured in the dept of Centre for Environmental Science and Engineering (CESE), Indian Institute of Technology (IIT), Kanpur.

The fluoride concentration of the water in which the specimen discs were immersed was measured by means of a fluoride ion selective electrode (ORION Model 290 A) connected to an ion selective electrode meter/ digital ion analyser.

The fluoride electrode is sensitive to changes in pH and so a buffer called as TISAB II (Total Ionic Strength Adjustment Buffer) must be added to any water specimen before testing in order to hold the pH of water between 5.0 to 5.5. The use of TISAB II frees fluoride ions bound to hydrogen and eliminates hydroxyl ion interference, so enabling an accurate measurement of the total fluoride content.

Statistical Analysis

The data of all specimens were entered into the computer using Microsoft Excel and subjected for statistical analysis. Data was analysed using the Statistical Package for Social Sciences (SPSS) version 23.0 software (SPSS Inc., Chicago, IL, USA). The normality of data was assessed by Shapiro-Wilk test. Descriptive statistics [mean and standard deviation (SD)] were calculated. Analysis of variance (ANOVA) and post hoc Tukey's test were used to determine significance in the release of fluorides among various groups at different time intervals. A p-value of less than 0.05 was considered as statistically significant.

Results

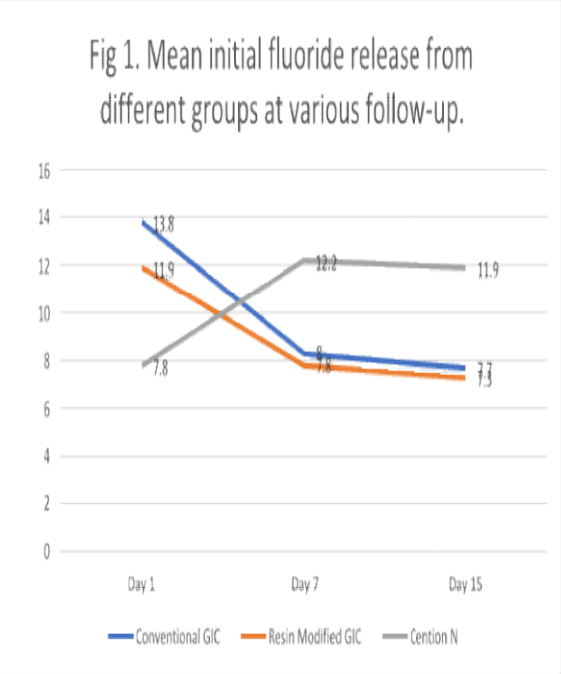
Forty-five specimens divided into three groups comprising of 15 specimens each were analysed. The findings revealed that there was a significant difference in fluoride release with different materials and also at different days $P<0.05$

Table 1: Mean and Standard Deviation (SD) values of initial Fluoride release (in ppm) in different groups at different time intervals

Follow-up	Groups (Mean ± Standard Deviation)			Total
	Conventional GIC	Resin Modified GIC	Cention N	
1st Day	13.8 ± 0.305	11.9 ± 0.912	7.8 ± 0.612	11.2 ± 0.843
7th Day	8.3 ± 1.021	7.8 ± 0.235	12.2 ± 0.521	9.4 ± 0.312
15th Day	7.7 ± 0.311	7.3 ± 0.203	11.9 ± 0.345	8.9 ± 0.125

$p<0.05$ is considered statistically significant

One Way ANOVA



Comparing the three groups [conventional GIC, Resin Modified GIC (RMGIC) and Cention N] the maximum cumulative initial fluoride release was related to GIC followed by RMGIC and Cention N. On comparison between 1st, 7th and 15th day, the fluoride release from all the materials was highest on 1st day and decreased sharply till the 7th day. Further gradual reduction in fluoride release from GIC and RMGIC was observed till the 15th day. The Cention N material showed an outburst in the mean values from Day 1 to Day 7 which remained almost constant over time [Table 1/Fig 1].

Discussion

Dental caries prevention through the use of fluoride in its different forms of application has been the object of several studies. A dogma had existed for many decades that fluoride had to be ingested and acted mainly pre-eruptively; however, recent studies conclude that preventive effects of fluoride for caries are almost exclusively topical.[4] As the constant presence of fluoride plays an important role in prevention, the success of topical treatment depends on the formation of fluoride reserves capable of releasing ions for prolonged periods of time.

This study was undertaken to evaluate and compare the amount and pattern of fluoride ion release from three different fluoride-releasing restorative materials. The various materials considered in this study are indicated for the restoration of a carious tooth in high as well as low-stress bearing areas.

The role of fluoride in exhibiting anti-cariogenic property and its remineralization potential has been discussed in the literature.[5] The filler content and nature of the glass-ionomer hydrogel matrix phase is responsible for fluoride release. The powder-liquid ratio of two- phase-systems, mixing procedure, curing time and the amount of exposed area as well as the different storage media affect the fluoride release. The specimens in the current study were not coated with any adhesives or protective agents from moisture contaminants. In vitro, fluoride leached from filling materials coated with an adhesive was reduced by a factor 1.5–4.5

In a previous study, the estimated fluoride release from a conventional GIC, RMGIC, compomer and a resin composite, which were stored in different media including deionized water, showed that conventional GIC was the one with highest fluoride release followed by RMGIC and least was from resin composite which is in partial agreement with this study. Kinetic findings demonstrated that the conventional and resin-modified glass ionomers had a similar pattern of fluoride release; however, the amount of daily and accumulated fluoride release of these materials were different.[6]

Alkasite material-Cention consists of alkaline-fillers, which produces acid-neutralizing ions. In its mixed state, the alkaline glass accounts for 24.6% by weight, which is responsible for a substantial amount of fluoride release? [3] The current study results indicate that Cention N had significantly low fluoride release at the end of day 1 when compared to tested conventional GIC and RMGIC. Whereas, at all the other time intervals, it has exhibited a significantly high fluoride release. This shows that Cention N lacks a burst effect but constantly releases fluoride over the period. Significantly high release of fluoride over the longer period may be due to a higher powder/liquid ratio and also a high amount of alkaline glass in its final state. [5]

Storage media influences the amount of fluoride release from the material and includes deionized water, artificial saliva, lactic acid, etc. The storage medium used in this study was deionized water. Deionized water provides near accurate readings of fluoride release because it has no ions present in it.9 a higher amount of fluoride release has been reported in artificial saliva and the pH-cycling solution, respectively. [10]

Various methods that have been employed to estimate the amount of fluoride release include spectrophotometer, ion chromatography, capillary electrophoresis, and fluoride ion electrode method. This method is equally sensitive as the standard electrode method is faster and less technique sensitive. Various authors have used this method for

fluoride ion estimation. [11, 12] The only shortcoming of using a selective ion electrode method is that it cannot detect the presence of fluoride compounds.

The clinical significance of the released fluoride is yet to be fully confirmed. Many factors such as the site into which the fluoride diffuses and the rate of diffusion will influence its anti-caries effectiveness. The ultimate goal of correlating fluoride release with actual caries reduction is an objective that can only be met by completing controlled clinical studies on materials with well characterized kinetics of fluoride release. Limited studies are seen in the literature, which evaluates and compares the capacity of fluoride recharge in Cention.

Conclusion

Under the limitation of this in vitro study; it could be concluded that the initial fluoride release was highest from Conventional GIC followed by Resin modified GIC, Cention.

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To cite this article: A Comparative Evaluation of Fluoride Release from Three Different Fluoride Containing Restorative Materials: An In Vitro Study, Dr. Sangeeta Samorekar, Dr. Asheesh Sawhney, Dr. Shridevi Nandamuri, Dr Pankaj Priyadarshi ,Rama Univ. J. Dent. Sci. 2018 December; 5(4): 21-24.