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Fluoride Ions Release Study Of Different GIF Materials

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Abstract

The purpose of this in vitro study was to compare & measure the release of fluoride ions from set tested materials, CGI (Pro-med), MGI (Ketac molar), and LCGI (Vitremer).

The tested materials were made as molds with certain dimensions and each mold was placed in vial containing 100 ml. of DDW. Every 24 hrs, 5 ml. of the solution was transferred into smaller tubes to measure the fluoride release using spectrophotometer. This procedure was repeated every 24 hrs. for 14 days.

The results revealed that the CGI (conventional glass ionomer) had higher release over other materials, then the MGI (modified glass ionomer) material, and finally the LCGI (light cure glass ionomer) with significant differences between them at $P< 0.05$.

The MGI material had higher fluoride ions release concentrations over the LCGI. However, the CGI had higher fluoride ions release concentrations over other materials.

Keyword: Glass ionomer, fluoride release, filling materials.

Introduction

Dentistry is undergoing enormous changes at the present time, and the field of operative dentistry is the very forefront of that transformation. The need for conservative, esthetic, and durable restorative material is a challenge. One of the respected restoratives filling material was the glass ionomer. Glass ionomer was developed in the late 1960 at the Laboratory of the Government Chemist and was first described in 1972 by Wilson and Kent ([1]. It was developed in an attempt to combine the successful properties of both the silicate and polycarboxylate cements [2]. Originally, the material was designed for the esthetic restoration of anterior teeth and it was recommended for use in restoring teeth with class III and V cavity preparations. The use of glass ionomer has broadened to encompass formulations as luting agents , liners, restorative materials for conservative class I and II restorations and core build – ups, and pit and fissure sealant [3]. One of the advantages of the glass ionomer is the fluoride ions release. The poly - acid attacks the glass to release cations and fluoride ions [4,5]. Fluoride ions release is proportional to the concentration available to diffuse from the matrix and/or residual silicate particles through to the restoration surface. Generally, fluoride ion release is relatively high during the first few days but that rate of release falls as fluoride concentration is depleted in the matrix. A critical level of the fluoride release over time never has been defined clinically. The absence of significant secondary caries is not evidence of fluoride ion effect.

For posterior composites, the incidence of secondary caries can be less than 3% at 10 years even in the absence of fluoride release. No clinical evidence indicates that glass ionomer restorative materials can produce comparable or better result. Nonetheless, fluoride release from restorative materials such as glass ionomer may have therapeutic effects that have yet to be demonstrated. Glass ionomer restoration seems very well suited for situations that involve high caries risks. These include patients who are known to be more susceptible to caries, patients with reduced or no saliva flow, or patients with oral disease that accelerate the pathogenic activities associated with caries. In some cases, when bonding composite to gingival areas with little or no enamel, a glass ionomer liner extended just short of the margins has been suggested as away to reduce caries risks if microleakage occurs. Fluoride release from glass ionomer material can provide resistance to marginal carious breakdown via two distinct mechanisms: the first, it has shown that glass ionomer restorations are more resistance to marginal carious break down, the second, it has been shown that GIs exert inhibitory growth effect on streptococcus micro-organisms due to their ability to release fluoride [4,6]. The initially high burst of fluoride release is due to the high concentration of fluoride that exists in the matrix immediately after the setting reaction is complete. During the initial acid dissolution of powder particle edges, a large amount of fluoride becomes part of the reaction product matrix. This fluoride diffuses quickly from the matrix exposed on the surface of the material and is only slowly replaced by fluoride diffusing from greater distances in the matrix below the surface or by fluoride diffusing from the particles into the matrix. Therefore, the long term release of fluoride is at much lower rates. Due to the porous nature of the cement matrix, fluoride ions pass through without affecting its physical make up [4].

Materials and Methods

1. Specimens preparation

The tested materials were mixed according to the manufacturer instructions. The specimens were made into pieces using composite testing mold (Helio-Test, Vivadent), the pieces have dimensions of 3, 3, and 3 mm. in width, height, and depth. The LCGI (light cure glass ionomer) was cured by light-curing device. Each material piece after setting was finished for any excess material at the line angles of the cubic piece.

2. Samples grouping

Each piece was placed in polyethylene vial containing 100 ml. of deionized distilled water of pH value (5.0) using acetic acid. Every 24 hrs, a pipette with a disposable tip was used to transfer 5 ml. of the solution from the vials into smaller coded tubes for measuring fluoride release from the tested materials using spectrophotometer. This procedure was repeated every 24 hrs. , for 14 days. The specimens were divided into three equal groups, with ten samples for each group, as shown in table (1).

3. Fluoride concentration measurement

The measurement of fluoride ions released was done with atomic absorption spectrophotometer. The measurement is based on the absorption of radiant energy of characteristic wave length by free atoms of the element. The diluted solution was aspirated into an air acetylene flame, in which the ground state fluoride atoms absorbed incident light from fluoride electrode [7,8]. Fluoride concentration in PPM was determined by comparison of sample absorbance reading with that of standard utilizing the calibration curve which was constructed, utilizing the concentration of different standards and their corresponding absorbance readings. Each sample was tested twice, and the mean was calculated for each sample.

Results

The descriptive statistics for the fluoride ions release study results with the mean values and the standard deviations of the fluoride ions release of all the tested materials in PPM, are presented in table (2). From table (2), the results revealed that the CGI had the highest fluoride ions release mean value with (17.78 PPM) for all the 14 days as compared with other materials.

While the LCGI had the lowest mean value with (13.56 PPM) for all the 14 days. However, for all the tested materials, the first day had the highest mean value with (24.46 PPM) and the day 14 had the lowest mean value with (8.16 PPM). By using LSD test for multiple comparisons, the results indicate significant difference at $P< 0.05$ between the tested materials for all the 14 days (from day 1 to day 14), table (3). Table (4), shows the testing of the homogeneity of variances, and it is clear that significant difference at $P< 0.05$ was obtained between all variables, using Levene test. By using one-way ANOVA with LSD of multiple comparison tests, the results have shown that there was a significant difference at $P < 0.05$ between all the variables (time and materials). (Table 5) (Fig. 1).

Discussion

One of the main advantages of the GI materials was the fluoride ions release. The fluoride is released from the glass particles on mixing & the presence of fluoride also has benefits in increasing translucency & strength & improving handling properties [9]. The fluoride release is maximum in the first few days & decreases rapidly to a lower level over weeks, & maintains low level for months. Most of fluoride is released as sodium fluoride which is not critical to the matrix, & thus does not result in weakening or disintegration of the set material. RMGI shows similar dynamics of fluoride release, although, for both types, the dynamics of release & the amounts released depend on the particular material & the experimental design [10]. The results of this study revealed that the CGI had the highest release among other materials. This result agree with the finding of Craig in 1997[4], Anusavice in 1996[6], Erickson and Glasspoole in 1995[11], Raggio et al in 2002[12], and Hrsted-Bindslev in 1994[13].

This may be explained by the action of the polyacrylic acid on the aluminosilicate glasses of the material with continuous release of anions & cations (one of them, the fluoride). However, the MGI material had higher release over the LCGI and comparable release with the CGI. This may explained by the action of PAA on the glasses resulting in continuous release of fluoride ions. This explanation is supported by Schricker et al in 2004[14]. Many previous studies were conducting the repeated measurements of the fluoride ions release over 14 days. This is due to observations found in many studies that much more of fluoride ions release would be at the first fourteen days. [7,8,15]. Almost always, the release had higher concentration at the first days and decrease steadily with the time. This finding agrees with that of Yip et al in 2002[16] and Wandera et al in 1996[17]. This may explained by that the initial high burst of fluoride release is due to the high concentration of fluoride that exists in matrix immediately after setting reaction is complete. This explanation is supported by research of Forsten in 1990[18].

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Table (1) Sample grouping in fluoride ions release study

Group	Tested material	Specimen
I	CGI	10
II	LCGI	10
III	MGI	10

Part Two: Between groups for all times

Group	Mean	SE	95% confidence interval	
			Lower bound	Upper bound
CGI	17.78	0.21	17.74	17.82
LCGI	13.56	0.21	13.51	13.6
MGI	16.325	0.21	16.28	16.36

Table (2): The descriptive statistics for the fluoride ions release study results
Part One: Between times for all the materials.

Time (days)	Mean	SE	95% confidence interval	
			Lower bound	Upper bound
1	24.46	0.46	24.37	24.55
2	23.26	0.46	23.17	23.35
3	22.15	0.46	22.06	22.24
4	20.66	0.46	20.57	20.75
5	19.4	0.46	19.31	19.49
6	18.03	0.46	17.94	18.12
7	16.16	0.46	16.07	16.25
8	14.69	0.46	14.6	14.78
9	13.06	0.46	12.97	13.15
10	12.39	0.46	12.30	12.48
11	11.23	0.46	11.14	11.32
12	9.99	0.46	9.9	10.0
13	8.75	0.46	8.66	8.84
14	8.16	0.46	8.07	8.25

Table (3): LSD test for the tested materials from day 1 to day 14 in fluoride ions release study results

Groups	LCGI	MGI
CGI	4.22 (0.000)	1.45 (0.000)
LCGI		-2.76 (0.000)

Table (4): Levene test for the fluoride ions release study results

Levene statistic	df1	df2	Sig.
4.471	41	378	0.000

Table (5): One-way ANOVA for the fluoride ions release study results

	Sum of seq.	df	MS	F	Sig.
Bet. groups	13403	41	326	52	0.00
Within groups	23.41	378	0.06		
Total	13426	419			

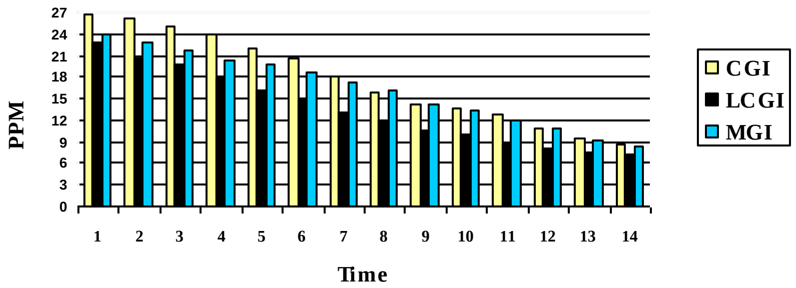

Fig.(1): Fluoride release of the materials