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Evaluation of fluoride release from three different Glass-ionomer luting cements at different time intervals

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ABSTRACT

Background and Aim: The fluoride released in oral cavity plays an effective role in preventing carries in lateral walls of the restoration cavities and remineralization of initial lesions. Dental materials are considerably different regarding the amount of fluoride release. This study aimed to determine the amount of fluoride release from three self-cure glass ionomer cements, Fuji I, Fuji Plus and SDS in distilled water.

Materials and Methods: In this experimental study, 8 disc-shape specimens (3×10mm) were prepared from three glass ionomers, Fuji I and Fuji Plus (CG, Japan) and SDS (Iran). Eight specimens of each material were placed in 7ml of distilled water and were stores in incubator at 37oC. The amount of fluoride release was measure at 1, 3, 7, 14, 28 and 56 days using a fluoride ion-specific electrode (Metrohm, Switzerland). Data were analyzed using repeated measurement ANOVA and LSD tests.

Results: The pattern of fluoride release was similar for the three materials. The amount of released fluoride from the three material in day 1 was considerably greater than the other days (Fuji I=28.07±0.26, Fuji Plus=35.97±0.19, SDS=41.08±0.36), followed by a gradual decrease over the study period. The least amount of fluoride release was recorded on day 56. The difference between the amount of fluoride release from the three glass ionomers was statistically significant (P=0.0001).

Conclusion: In addition to revealing a statistically significant difference between the three glass ionomers in terms of fluoride release, the results of this study suggests using SDS glass ionomer in patients susceptible to caries.

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Introuduction

One of the problems of using restorations, particularly in crowns, is decaying of the teeth crown. To decrease this problem, various methods are offered such as proper hygiene maintenance, using dental floss and mouthwashes, as well as complete marginal adaptation of the crown. Using fluoridated mouthwashes and fluoride-containing cements such as glass ionomers have revealed successful results.[1] Topical and/or systemic use of fluoride has been proven to be effective in preventing dental caries. Fluoride prevents demineralization of dental tissues and facilitates the remineralization process. [2] In order to prevent dental caries and increase the fluoride's contact with teeth, dental materials capable of fluoride releasing have been manufactured. [1, 2]

The amount of fluoride ion released from various dental materials is among the features that must be considered, because fluoride ion is one of the major factors that decrease the prevalence and intensity of dental caries[1] The restoration margins are potential pathways for penetration of cariogenic microorganisms that are present in the normal flora of human mouth.[2] Determining the amount of fluoride released from various glass ionomers have always been of great importance to researchers [3], because in most cases the reason of treatment failure in fixed partial prostheses is the caries beneath the restoration in the base teeth .[1]There are several reports concerning the amount of fluoride release from various materials in previous studies. [3] Different cements have different physical characteristics and instructions. Currently 10 types of cements are available. Zinc phosphate, zinc polycarboxylate and glass ionomer are three common cements used in prosthesis, and for attaching the crowns and bridges .[4]A direct relation has been reported between the amount of fluoride release and bacterial growth. Several studies have been performed on the nature of fluoride release from various materials. [1-4] In-vitro studies have demonstrated that glass ionomer cements are able to provide fluoride for the enamel with which they are in contact. In most cases, sound enamel can still be observed in the margins of the cutting edge, especially in full metal cutting, and this procedure continues over a long period. Moreover, the absorbed fluoride has been observed to have been spread to the underlay and to have enhanced the teeth resistance more than the contact area. [5]It has also been noticed that very low concentrations of fluoride (even 0.1 ppm) facilitate the deposition of apatite in saliva, and subsequently mineralization improves. [6] In oral environment, presence of plaque and pellicle on the surface of glass ionomers with microscopic surface roughness and saliva should be considered, since they might affect the absorption and releasing process. [7]

Although capability of fluoride release is one of the beneficial features of glass ionomers, there is no precise information regarding the amount of fluoride release in Fuji I, Fuji Plus and SDS glass ionomers. Therefore, the current study was designed to compare the amount of fluoride release in these three types of glass ionomers and was carried out in School of Dentistry of Tehran Islamic Azad University, 1391.

Materials and Methods

With respect to the previously performed studies, the minimum number of samples needed for this experimental study in each group was 8, constituting a total of 24. [10]

Preparing the specimens: to prepare the samples, a specific stainless steel mold with initial diameter of 10mm and thickness of 3mm was used. This 8×5mm mold consisted of two metal plates having male and female ends, and it was 3mm thick. A hole with initial diameter of 10mm was prepared. The two parts of the mold were placed on glass slab, and after they were fitted, the mold was filled with the desired material. Then another slab was pressed on it with pressure to push out the excess material and air bubble in the fabricated samples. Eight samples were prepared of each material according to the manufacturer's suggested powder-to-liquid ratio, by using mixing method.

This study was done in Basic Sciences Laboratory of School of dentistry, Islamic Azad University. After being removed out of the mold, all manufactured specimens were placed in distill water and were stored in incubator (Behdad Co.; Iran) at 37°C throughout the experiment duration. To prevent the solution from being saturated with fluoride ion, the solutions of all samples were renewed daily. The amount of fluoride release was measured at days 1, 3, 7, 14, 28 and 56. Prior to

each measurement, the specimens were taken out of the container and were rinsed with 1ml of double distilled water. This water was added to the previous solution and the specimens were transferred to a new plastic dish containing fresh solution. Seven milliliter of the related solution, as well as that 1ml water which was used for rinsing the specimens were added to 4ml of TISAB II buffer solution and was used for measuring the amount of released fluoride. [8]

The amount of fluoride in the solution was measure by using potentiometer (PH/Ion meter, Metrohm; Switzerland). Before using the fluoride ion-specific electrode, it was severely shaken several times so that the probable bubbles disappear. The electrode was immersed into the solution and the container was simultaneously shaken so that the fluoride would be released in the solution uniformly. When the number shown on the screen of the potentiometer became stable, the obtained number was recorded, indicating the amount of fluoride in the solution in ppm.

The electrode was then taken out of the solution and was thoroughly rinsed with large amount of distill water, dried, calibrated and used again for the next sample.

Data were analyzed using SPSS Software, Version 18.

Repeated measurement ANOVA and LSD post hoc tests were used as appropriated.

Results

In this study the amount of fluoride release from three types of self-cure glass ionomer cements, Fuji I, Fuji Plus and SDS was measured at 6 definite time intervals over a 56-day period. The samples were 8 specimens from each type of glass ionomers and a dish of distilled water containing no type of glass ionomer, considered as control. The amount of fluoride in control container was zero in all days of follow-up.

Repeated measurement ANOVA between the defined groups revealed that the amounts of fluoride release between the three groups at the 1, 3, 7, 14, 28 and 56 days were significantly different (P=0.0001). On the days 1 and 3, the highest amount of fluoride release was observed respectively in SDS, Fuji Plus and Fuji I. But on day 7, the least amount of fluoride release was measured in SDS group, indicating faster decline of fluoride in this material. Meanwhile, Fuji Plus still had the highest amount of fluoride release.

From the day 7 forth, Fuji Plus, SDS and Fuji I had respectively the highest to lowest amount of fluoride release. The amount of fluoride release from different groups decreased over the days of measurement. The highest amount of fluoride released from the three groups was observed on the day 1, and the highest amount on that day was related to SDS and the least was related to Fuji I.

Table 1- The mean±SD amount of fluoride release (ppm) from the studied specimens at different times

Time of measurement (per day) / Type of glass ionomer	1	3	7	14	28	56	P-Value
SDS	41.08±0.36	20.83±0.54	5.07±0.30	3±0.21	1.99±0.21	1.26±0.17	0.001
Fuji I	28.07±0.26	11.00±0.19	5.95±0.16	2.20±0.20	1.11±0.12	0.92±0.10	0.001
Fuji Plus	35.97±0.19	16.98±0.22	11.10±0.20	5.22±0.30	3.18±0.18	2.81±0.15	0.001
P. Value	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.001

According to the results of LSD post-hoc test and table 2, the claim can be made that in all days of measurement (1, 3, 7, 14, 28 and 56) there was statistically significant difference between the three groups regarding the mean amount of fluoride release.

Concerning the pattern of fluoride release in the first 24 hours, there was a rapid release of high levels of fluoride, followed by a sudden drop in the amount of released fluoride, continued with a gradual release of a lower amount; such that all studied specimens had fluoride release until the last day of follow-up.

Table 2- Pairwise comparisons between the three groups, SDS Fuji I and Fuji Plus

Glass ionomer groups	P. Value Day 1	P. Value Day 3	P. Value Day 7	P. Value Day 14	P. Value Day 28	P. Value Day 56
Fuji Plus - SDS	0.001	0.001	0.001	0.001	0.001	0.001
Fuji I - SDS	0.0001	0.0001	0.06	0.06	0.07	0.07
Fuji I – Fiji Plus	0.01	0.01	0.01	0.01	0.01	0.01

Discussion

This study evaluated fluoride release from three glass ionomers (Fuji Plus, Fuji I, and SDS) over a 56-day period. Performing ANOVA test between the defined groups revealed a significant difference between the amounts of fluoride released from the three groups on the days 1, 3, 7, 14, 28 and 56 (P=0.0001). On the days 1 and 3, SDS, Fuji Plus and Fuji I had respectively the highest amount of fluoride release. But on the day 7, the least amount of fluoride release was observed in SDS specimens, indicating faster decline of fluoride level in this material; whereas Fuji Plus had the highest amount of fluoride release.

From the 7th day forth, Fuji Plus, SDS and Fuji I had respectively the highest and lowest amount of fluoride release. On the other side, the amount of fluoride release from different groups decreased over the period of measurement. The highest amount of fluoride release from the three groups was recorded on the first day, and the highest amount on the first day was related to SDS (41.8ppm) and the least was related to Fuji I (28.07ppm).

Various studies like the study by Chan WD et al. (2006) revealed that the different ratio of powder-to-liquid can affect the solubility of the solutions and fluoride release of the compounds. In other words, lower ratio increases the solubility and fluoride release. [9] In the current study, the powder-to-liquid ratio was determined based on the manufacturer's instruction.

It must be noted that enamel softening is not directly related to the amount of fluoride release from the newly mixed glass ionomer cement. In fact, after a definite concentration of fluoride is released –that is probably so high in the primary phase of fluoride release- excessive amounts cannot protect the enamel. Generally, prolonged release of fluoride is most probably much more important that the amount released [10] The results of the present study was in agreement with what Shafiezadeh et al. found; they reported the amount of fluoride release from SDS glass ionomer to have been higher than SDI and GC. [11]

Dental caries has a multifactorial nature, and the minimum level of fluoride needed for anyone depends on the features of oral environment in that individual. Factors such as where fluoride is released in the mouth, as well as the dilution rate of fluoride by saliva influence the anti-caries effect of fluoride. Nevertheless, the results have demonstrated that using dental materials with long-term fluoride release is highly beneficial and advised, particularly in patients with moderate to high incidence of dental caries. [12-14] Several studies have investigated various glass ionomers in terms of amount and pattern of fluoride release. All these researches observed that the process of fluoride release is similar and is done in two steps; first a rapid and short-term release in the first 24 hours, and then a gradual and long-term release (11, 15 and 16). It was approved by the present study. Bahadure et al. and Zalizniak et al. explained that in the first stage, due to the reaction between the particles of glass and polyalkenoic acid that is observed in the primary setting, high levels of fluoride is released rapidly. The second stage is the result of balance between the glass particles in the structure of material and release of fluoride in the matrix, causing the fluoride to release gradually with lower levels (17, 18).

Yap Aug et al. (2002), compared the amount and pattern of fluoride release from a compomer and Fuji I glass ionomer. They found only glass ionomer to have shown rapid and high level release of fluoride during the first 24 hours; while

compomer did not follow this pattern. [19] There are other studies approving this result. [20,21] In the current study, all the three studied glass ionomer followed the above mentioned pattern. However, comparing Fuji Plus, SDS and Fuji I glass ionomers demonstrated significant difference.

Several factors affect the fluoride release from dental materials including temperature, powder-to-liquid ratio, mixing the material, setting time and porosity. [22] In this study, the proportion of powder to liquid and mixing method were performed based on the manufacturer's instruction. Also the temperature was tried to be equal for all specimens, hence they were stored in incubator at 37°C throughout the experiment. One of the reasons of higher fluoride release from SDS glass ionomer might be porosity. In the study performed by Sidhu, it was found that high level of porosity increased the penetration of the solution into the glass ionomer matrix, and consequently more fluoride was absorbed and released . [23]Dhull et al. assessed the compressive strength, fluoride release and resorption pattern in diverse restoration material and reported that fluoride release and compressive strength are inversely related .[24] Likewise all previously mentioned studies; the current study measured the fluoride release through potentiometry method by using fluoride ion sensitive electrode. Only in the study enrolled by Yap Aug et al., fluoride release was measured through capillary electrophoresis method using FASI, which was a different method. [19]

Conclusion

The results of this study revealed a statistically significant difference in fluoride release between the three glass ionomers. This study also advises using SDS glass ionomer in patients susceptible to caries.

Conflict of interests

Authors report no conflict of interest related to this study.

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