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Fluoride Release from Polyacid-Modified Composites (Compomers) in Artificial Saliva and Lactic Acid

SUMMARY

The slow release of fluoride from restorative materials has been clinically important because of its anticariogenicity. The aim of this study was to assess the fluoride release from compomers in lactic acid and artificial saliva at different period of times. 42 specimens (n= 7 per group) in disc forms (7 mm diameter, 2 mm thickness) from 3 different compomers (Compoglass F, Dyract AP, Glasiosite) were placed in artificial saliva (pH = 7.0) and lactic acid (pH = 4.0). The amount of the fluoride in the solutions was measured at 1st, 7th, 14th, 21th and 28th day by means of the fluoride ion selective electrode. The fluoride amount was calculated by concentration (ppm).

The 3-way Analysis of Variance (ANOVA) and the Multiple Comparison Tests (Duncan) indicated that the relative amount of fluoride release was dependent on both the material and the storage medium. Significant differences were also found between the different types (P<0.01). A time dependent increase in the fluoride content was observed for all the compomers in both media. For all the tested materials, the fluoride release was higher in the artificial saliva (P<0.01). The amount of fluoride release was the most from Compoglass F (80.7- 45.2 ppm), followed by Dyract AP (58.2 - 14.7 ppm) and Glasiosite (19.2-12.2 ppm) at 28th days, in both artificial saliva and lactic acid, respectively. The least amount of fluoride release was observed at the first day ranging between 3.5 - 6.7 ppm in artificial saliva, and 2.2 - 6.5 ppm in lactic acid. Fluoride release was evident for all the compomers, but the rate of release varied considerably between the materials.

Keywords: Compomers; Artificial Saliva; Lactic Acid; Flouride Release

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Introduction

New restorative material, polyacid-modified composites or compomers have been developed[1,2]. These materials adhere to dentin and enamel, have a stable matrix structure, release fluoride, and reduce microleakage. These materials are a composite resin containing fluoride releasable filler. Compomer contains a light activated polymerizable dimethacrylate monomer and one containing carboxylic acid group[2,3]. To determine which material has optimal fluoride release for caries resistance, the relative concentrations and the duration of fluoride release should be examined among materials. Many factors affect fluoride release. There are several studies for the fluoride release from compomers. The use of different experimental condition in the respective studies also affects the results such as the manipulation of the material, powder-liquid ratio, the way of mixing, different amount of exposed area for the specimens or the nature of the storage medium. Lactic acid and artificial saliva were often used for the dissolution in experiments, and most of the studies have been conducted *in vitro*. Therefore, the actual results in clinical conditions could only be speculated. The acid is most likely to exist in the oral environment and relevant to caries initation[4-8].

This *in vitro* study evaluated a short time fluoride release from 3 commercial compomers into artificial saliva and lactic acid, in an effort to simulate clinical conditions.

Material and Methods

3 different compomers, namely Compoglass F, Dyract AP, and Glasiosite were selected for this study (Tab. 1).

42 specimens for 2 different testing media (artificial saliva and lactic acid, n = 7 per group) were prepared in disc forms (7 mm diameter and 2 mm thickness), according to the manufacturers' instruction. The specimens were light cured both from the bottom and the top of the mold for 20 seconds, which made 40 seconds totally. After their polymerization, they were removed from the teflon molds and placed in individual plastic tubes containing 2 ml of de-ionized water and incubated for 24 hours at 37 ^{0}C.

Table 1. The materials and the manufacturers of the products

Materials	Chemical Composition
Compoglass F Ivoclar, Vivadent, Münich, Germany	4 EDMA/TEGDMA BisPMA, Photo initiators, Ba-Al-fluorosilicate-glass, Stabilizer Ion-leachable glass, Yb trifluoride
Dyract AP Dentsply, DeTrey, Konstanz, Germany	UDMA polymerizable resins, TCB resin, St-Al-Na-P-fluorosilicate-glass, Strontium fluoride, Photo initiators, Stabilizers
Glasiosite Voco,Cuxhaven, Germany	Bis-GMA/TEGDMA, Diurethan-dimethacrylate Ion-leachable glass

Before each fluoride concentration measurement, the calibration curve was obtained. The artificial saliva was prepared according to Karantakis et al[9]. Each specimen was placed separately in plastic tubes containing 10 ml artificial saliva and 10 ml lactic acid. All specimens were stored at 37 ^{0}C during the time of each measurement.

Measurements were made at the intervals of 1th, 7th, 14th, 21th, 28th days. Measurements were repeated 3 times and the concentration values were averaged. Data were analysed by using a calibration curve. Before each measurement, 5ml artificial saliva was taken from the plastic tube and then 5 ml fresh artificial saliva was added in this plastic tube for the previous storage solution.

In order to measure the fluoride concentration, 5 ml of the artificial saliva was mixed with 14 ml distilled water and 1 ml TISAB solution (Orion Research Inc, 940911) and fluoride ion-specific electrode (combination electrode Fluoride 960900; Orion Research Inc) was used to read the fluoride content of the solution in parts per million (ppm). To measure fluoride release of compomer materials into the lactic acid (pH= 4; 10^{-3}M) similar protocol was conducted as for artificial saliva.

The data were analyzed by using 3-way Analysis of Variance (ANOVA) and Multiple Comparison Test (DUNCAN).

Results

The mean fluoride release values and standard deviations of each compomer materials were shown in tables 2 and 3.

Table 2. The mean fluoride release values and standard deviation of each compomers in artificial saliva

Materials	1st day	7th day	14th day	21st day	28th day
Compoglass F	4.7± 0.2 (A)e	26.7± 0.6 (A)d	58.5± 0.8 (A)c	75.1± 0.7 (A)b	80.7± 0.8 (A)a
Dyract-AP	6.7± 0.3 (A)e	28.5± 0.8 (A)d	48.7± 1.3 (B)c	56.2± 0.7 (B)b	58.2± 0.7 (B)a
Glasiosite	3.5± 0.3 (A)e	8.7± 0.5 (B)d	12.7± 0.5 (C)c	17.7±0.5 (C)b	19.7± 0.5 (C)a

Table 3. The mean fluoride release values and standard deviations of each compomer in lactic acid

Materials	1st day	7th day	14th day	21st day	28th day
Compoglass F	6.5± 0.3 (A)e	22.7± 0.3 (A)d	32.3± 0.5 (A)c	41.2± 1.2 (A)b	45.2± 0.2 (A)a
Dyract-AP	2.7± 0.2 (B)d	7.3± 0.3 (B)c	12.7± 0.8 (B)b	12.8± 0.3 (B)b	14.7± 0.3 (B)a
Glasiosite	2.2± 0.3 (B)d	3.5± 0.3 (C)d	7.2± 0.3 (C)c	10.2± 0.3 (B)b	12.2± 0.2 (B)a

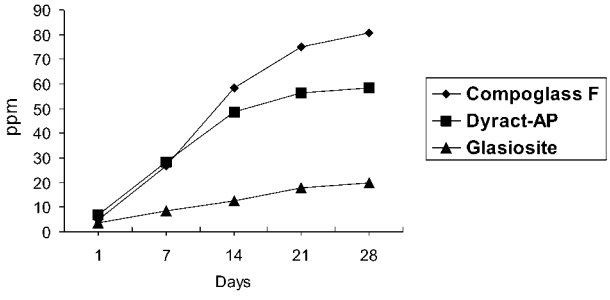

Figure 1. Fluoride release from 3 different of compomers in artificial saliva

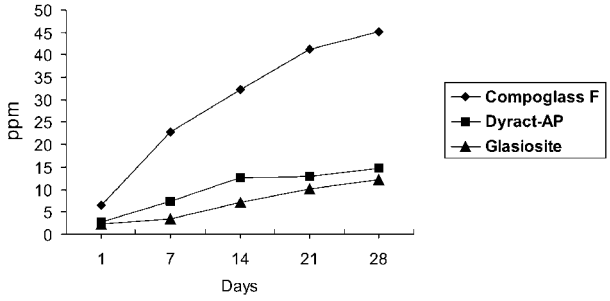

Figure 2. Fluoride release from 3 different compomers in lactic acid

Significant differences in fluoride were found among the 3 different compomers in both artificial saliva and lactic acid ($P<0.01$). For all the tested materials, fluoride release was significantly higher in the artificial saliva than in the lactic acid (Figs. 1 and 2). All brands of compomers released increasing amounts of fluoride as a function of time, but the rate of release varied considerably among the materials.

The amount of fluoride release in descending order was the most from Compoglass (80.7 - 45.2 ppm), followed by Dyract-AP (58.2 - 14.7 ppm) and Glasiosite (19.2 - 12.2 ppm) at the end of 28 days, in both artificial saliva and lactic acid, respectively. The least amount of fluoride release was observed at the first day, ranging between 3.5 - 6.7 ppm in artificial saliva and 2.2 - 6.5 ppm in lactic acid. Fluoride release was evident for all the selected compomers. The least fluoride release was found with Glasiosite in lactic acid.

Discussion

Several investigations have been performed on fluoride release from various dental restorative materials, including resin composites, glass-ionomer cements, and compomers[10-11]. In these studies, fluoride release was evaluated using various experimental designs and storage media. It is generally accepted that fluoride should be released slowly, through a diffusion process, without leading to the deterioration of physical properties of the material. Sales et al[12] reported that the fluoride, aluminium and strontium ions from compomers were released much more in the lactate buffer (pH 4.1) than in distilled water. The pattern of fluoride release from the materials was similar, peaking with in the first few days after being placed in the storage solutions. The pH of the environment affected the fluoride release differently among the materials.

All the compomer materials evaluated in this study demonstrated low fluoride release initially at the first day, but the amount increased at 7th and 14th days. The fluoride release then proceeded with a slow increase at 21th and 28th days of observation periods. The rate of the release remained relatively constant after 21th day. Even though all the materials tested demonstrated similar dissolution patterns during our examination period, the amount of fluoride release from the different compomers varied from one to another at various time intervals. This depended not only on the concentration of fluoride, but on whether it could diffuse out from within the material. This finding is in accordance with Attin et al[13], where maximum fluoride release from compomers was detected within the 1st day after setting, followed by a decrease in the rate after a few days. Vermeesch et al[14] observed that the fluoridated resin composites released fluoride in small amounts, it was approximately 10 times less than compomers during the first day.

In order to understand the differences between the materials, it is important to note that they all contain fluoride in their glass filler particles. Fluoride release depends not only on the concentration of fluoride, but also on diffusion from the material. The difference between the fluoride release mechanism in glass-ionomer cements and compomers at short immersion periods may be due to the loss of bonding property of fluoride in compomers. Therefore, after polymerization a less amount of fluoride containing glass fillers will be exposed to the storage medium.

The relatively low fluoride leaching into the artificial saliva is important because many leaching studies use water as the medium[15-18].

It was also observed in this study that fluoride release from the compomer materials was dependent on the storage medium as statistically significant differences were observed in the fluoride release amount between artificial saliva and lactic acid. Furthermore the amounts of fluoride ions released from compomers, through the 21th day were lower than the reported values for glass-ionomer cements.

The setting mechanism of the compomers was entirely a free-radical polymerization that was proposed to be a relatively slow reaction. Once the monomer of compomers were polymerized and exposed to saliva, the acid groups caused the resin to take up the moisture, thereby activating the acid-base reaction between the acidic functional groups and the basic glass filler[19-21].

Forsten[22] have shown that the compomers release fluoride less than conventional and light-polymerized glass-ionomer cements being exposed to storage medium.

Conclusions

1. Significant differences in fluoride release were found among the 3 different compomers in both artificial saliva and lactic acid.
2. For all the tested compomers, fluoride release was significantly higher in artificial saliva than in lactic acid.
3. The pattern of fluoride release was similar for all of the examined materials.
4. The pH of the environment strongly affected the fluoride release from the materials.

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