FLUORIDE RELEASE FROM CONVENTIONAL GLASS-IONOMER CEMENTS AND POLYACID-MODIFIED COMPOSITE RESINS

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SUMMARY: Fluoride release into deionized water from two glass-ionomer cements (Aqua Ionofil and Ceramfil β) and two polyacid-modified composite resins or compomers (Hytac and Dyract AP) was examined over different time periods. Nine cylindrical specimens (2.5 x 8.5 mm) of each material were prepared and allowed to stand in deionized water. The resulting solutions were analyzed for fluoride by the Alizarin colorimetric method on the 1st, 7th, 30th, and 120th days. The smaller release of fluoride from the compomers seemed to be fairly linear from day 7 to day 120, whereas most of the fluoride release from the glass-ionomer cements appeared to have occurred by day 30 and afterwards was very slow to day 120. Overall, the two compomers exhibited less fluoride release than the two conventional glass-ionomer cements, and the differences were statistically significant ($p<0.05$). The greatest amount of fluoride was released from the conventional glass-ionomer Ceramfil β, and the least amount from the compomer Dyract, for which only one previous study could be found.

Keywords: Dental compomers; Fluoride release; Glass-ionomer cements; Polyacid- modified resin composites.

INTRODUCTION

Mercury toxicity from amalgam dental fillings and their potential for creating problems in the environment and for human health have prompted the development of new restorative materials. The leading alternatives among these are glass ionomer cements.[1,2] According to current understanding, restorative materials that slowly release fluoride exert a local cariostatic effect. Not only would secondary caries be reduced at restoration margins, but adjacent teeth are also believed to benefit from constant fluoride release.[3] For this purpose, glass ionomer cements have desirable properties in that they help prevent recurrence of caries by releasing fluoride over a long period.[4] Thus they function in accord with the major cariostatic mechanism of fluoride, which is believed to be its action to promote remineralization and to influence the morphology of teeth by reducing enamel solubility and by suppressing oral cariogenic bacteria.[5] Although the minimum local concentration of fluoride release required to inhibit demineralization has not been determined, it is reported that the cariostatic ability of fluoride releasing restorative materials is significant.[6, 7]

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Hybrid restorative materials comprising resin ionomers and components of conventional glass ionomers have been widely introduced and accepted by the dental profession in recent years. This category includes resin-modified glass-ionomer cements and polyacid-modified resin composites or compomers, which were developed to overcome the problems of traditional restoratives, such as moisture sensitivity and reduced early strength, while maintaining their clinical advantages of command settings, adhesion to tooth structures, adequate occlusal load strength, fluoride release, and aesthetics.[2] The presence of glass particles in glass-ionomer cements and the powder/liquid ratio in polyacid-modified composite resins should have more influence on fluoride release than material type.[8]

In their present form, compomers may provide less caries inhibition than glass–ionomer cements. Still, compomers are felt to offer an attractive alternative to existing restorative materials, even though they apparently do not have as much caries inhibition capability as conventional glass-ionomer cements.[9] There are over 50 studies on fluoride release from the compomer Dyract but only one on Hytac.[10]

The aim of the present study was to determine the fluoride release from two glass ionomer cements and two compomer restoratives after the 1st, 7th, 30th, and 120th days of incubation in deionized water.

MATERIALS AND METHODS

Two polyacid-modified resin composites, or compomers (Hytac, Espe Dental AG, Seefeld, Germany, and Dyract, Dentsply DeTrey GmbH, Konstanz, Germany), and two conventional glass-ionomer cements (Aqua Ionofil, Voco, Cuxhaven, Germany, and Ceramfil β P.S.B Dental Co. Ltd, Kent, UK) were used in our study. Nine specimens of each material were prepared according to the manufacturers' instructions and inserted into disposable cylindrical PVC moulds 2.5 mm in length x 8.5 mm in diameter, and their average weights were 0.37 ± 0.02 g. Each specimen was placed in a glass vial containing 50 mL of deionized water and stored at room temperature (25 ºC). The resulting solution was analyzed for fluoride on the 1st, 7th, 30th, and 120th days by the colorimetric alizarin method as cumulative. In brief, 0.5 mL aliquots were removed from each mixture on the specified days, 1.25 mL of acid-zirconyl-alizarin reagent was added, and, after 1 hr, the absorbance was measured at 400 nm in a spectrophotometer (Shimadzu 160 Å, Kyoto, Japan) using quartz cuvettes.[11] Standard fluoride solutions were prepared to produce the absorbance values concentration curve.

The data were analyzed statistically by analysis of variance and Duncan's multiple range tests.

RESULTS

The release of fluoride into the water from different materials on the 1st, 7th, 30th, and 120th days is shown in the Figure as numerical values of cumulative fluoride released per time interval.

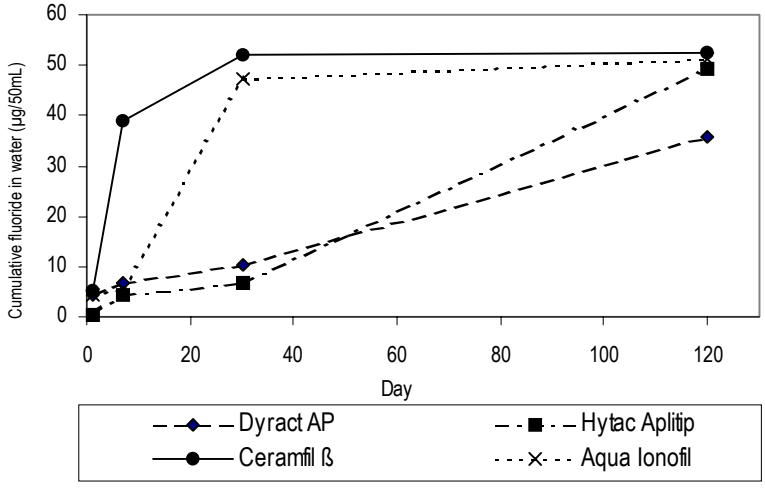

Figure. Cumulative fluoride release into 50 mL of deionized water from 2.5 x 8.5 mm cylindrical samples of filling material used.

Conventional glass-ionomer cements exhibited greater fluoride release than the compomers at a statistically significant level. From day 7 to day 30, the release of fluoride was higher for the conventional glass-ionomer cements. From day 30 to day 120, however, the release of fluoride was higher for the compomers. The smaller release of fluoride from the compomers seemed to be fairly linear from day 7 to day 120, whereas most of the fluoride released from the glass-ionomer cements appears to have occurred by day 30 and was then very slow after that to day 120. Ceramfil β, had the highest fluoride release overall. Except for the analysis on day 1, significant differences were observed among the all tested materials. Cumulative fluoride release of Hytac was higher by day 120 compared to Dyract. As seen in the Figure, fluoride release from Hytac on the first day was significantly lower than from Dyract and the other materials. Analysis of variance and Duncan's multiple range tests ($p<0.05$) indicated that there were significant differences in fluoride release between filling materials and times. The cumulative fluoride release was in the order of Ceramfil β, Aqua Ionofil, Hytac Aplitip, and Dyract AP, respectively.

DISCUSSION

Numerous investigations have been performed on fluoride release from restorative materials containing fluoride. In the present study the fluoride released by the conventional glass-ionomer products was higher than that from the polyacid-modified resin composites. This result is in agreement with the studies of Bala *et al* [12] and of Bertacchini *et al,*[13] who found that conventional acid-base glass-ionomer cements released more fluoride than compomers.

Some studies have demonstrated that glass ionomer cements show much more anti-cariogenic properties than polyacid-modified composites. In other words, compomers appear to provide less caries inhibition than glass-ionomer cements.[9,14] Our measured value of *ca* 35 μg/50 mL for cumulative fluoride release from the Dyract sample after 120 days agrees with data of a previous study for this compomer.[15] Therefore, this value can be accepted as typical for this type of fluoride-releasing dental restorative material. We also found that most of the fluoride released from the two glass-ionomers occurred by day 30. Again, this result agrees with results of a previous study indicating that compomers do not produce an initial burst of fluoride release but remain relatively constant in their rate of fluoride release.[15] By contrast, after initially high levels of fluoride release, the two glass-ionomer materials had a small stable fluoride release between day 30 and day 120, in agreement with findings of other studies.[8, 16-18]

The pH of the environment usually has a strong effect on fluoride release from these materials. For example, a significant difference was found for the amounts of fluoride released in lactic acid *vs*. water and artificial saliva, whereas, there was no significant difference in the amounts of fluoride released in water *vs*. artificial saliva.[19,20] Therefore, in the present study, deionized water was used.

This study has demonstrated that the initial and prolonged fluoride release rates of the compomer Dyract were lower than for the two conventional glass-ionomer cements and the other compomer Hytac and is confirmed by the findings of other authors.[21, 22]

The fact that glass-ionomer cement releases more fluoride than polyacid-modified resin composites may be partially due to the poor solubility of fluoride containing salts (ytterbium fluoride) and to a more tightly bound and/or less hydrophilic matrix of the polyacid-modified resin composites

REFERENCES

1 Willams P. Goodbye amalgam, hello alternative? J Can Dent Assoc 1996;62:139-44.
2 Hse KM, Leung SK, Wei SH. Resin-ionomer restorative materials for children: A review. Aust Dent J 1999;44:1-11.
3 Donly KJ, Nelson JJ. Fluoride Release of restorative materials exposed to a fluoridated dentifrice. ASDC J Dent Child 1997;64:249-50.

4 Fukazawa M, Matsuya S, Yamane M. Mechanism for erosion of glass-ionomer cements in an acidic buffer solution. J Dent Res 1987;66:1770-4.
5 Grobler SR, Rossouw RJ, Van Wyk Kotze TJ. A comparison of fluoride release from various dental materials. J Dent 1998;26:259-65.
6 Chung CK, Millett DT, Creanor SL, Gilmour WH, Foye RH. Fluoride release and cariostatic ability of a compomer and a resin-modified glass ionomer cement used for orthodontic bonding. J Dent 1998;26:533-8
7 Creanor SL, Saunders WP, Carruthers LM, Strang R, Foye RH, Effect of extrinsic fluoride concentration on the uptake and release of fluoride from two glass ionomer cements. Caries Res 1995;29**:**424–6.
8 Vermeersch G, Leloup G, Vreven J. Fluoride release from glass-ionomer cements, compomers and resin composites. J Oral Rehabil 2001;28:26-32.
9 Millar BJ, Abiden F, Nicholson JW. *In vitro* caries inhibition by polyacid-modified composite resins ('compomers'). J Dent 1998;26:133–6.
10 Vercruysse CW, De Maeyer EA, Verbeeck RM. Fluoride release of polyacid-modified composite resins with and without bonding agents. Dent Mater 2001;17:354-8.
11 Clesceri LS, Greenberg AE, Eaton AD, editors. Standard Methods for the Examination of Water and Wastewater, 16th ed. Washington: American Public Health Assoc; 1985. p. 413.
12 Bala O, Uctasli M, Can H, Turkoz E, Can M. Fluoride release from various restorative materials. J Nihon Univ Sch Dent 1997;39:123-7.
13 Bertacchini SM, Abate PF, Blank A, Baglieto MF, Macchi RL. Solubility and fluoride release in ionomers and compomers. Quintessence Int 1999;30:193-7.
14 Vermeersch G, Leloup G, Vreven J. Evaluation technics of the anticaries potential of fluoride-releasing materials. Rev Belge Med Dent 1998;53:278-94.
15 Shaw AJ, Carrick T, McCabe JF. Fluoride release from glass-ionomer and compomer restorative materials: 6-month data. J Dent 1998;26:355-9.
16 Miller BH, Komatsu H, Nakajima H, Okabe T. Effects of glass ionomer manipulation on early fluoride release. Am J Dent 1995*;*8:182-6.
17 Weidlich P, Miranda LA, Maltz M, Samuel SM. Fluoride release and uptake from glass-ionomer cements and composite resins. Braz Dent J 2000;11:89-96.
18 Khouw-Liu VH, Anstice HM, Pearson GJ. An *in vitro* investigation of a poly (vinyl phosphoric acid) based cement with four conventional glass-ionomer cements. Part 1: Flexural strength and fluoride release). J Dent 1999;27:351-7.
19 Karantakis P, Helvatjoglou-Antoniades M, Theodoridou-Pahini S, Papadogiannis Y. Fluoride release from three glass-ionomers, a compomer, and a composite resin in water, artificial saliva, and lactic acid. Oper Dent 2000;25:20-5.
20 Behrend B, Geurtsen W. Long-term effects of four extraction media on the fluoride release from four polyacid-modified composite resins (compomers) and one resin-modified glass-ionomer cement. J Biomed Mater Res 2001;58:631-7.
21 Yip HK, Smales RJ. Fluoride release and uptake by aged resin-modified glass-ionomers and a polyacid-modified resin composite. Int Dent J 1999;49:217-25.
22 Forsten L. Resin modified glass-ionomer cements: fluoride release and uptake. Acta Odontol Scand 1995;53:222-5.

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