The effect of acid and fluoride release on the antimicrobial properties of four glass ionomer cements

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Introduction

Glass ionomer cements reportedly bond to tooth surfaces by physicochemical interaction and slowly release fluoride.[1] Two mechanisms are involved in fluoride release, a rapid surface elution and a slower bulk diffusion of fluoride ions.[2,3] The greatest release of fluoride reportedly occurs in the first 24 hr, and then remains constant for several months before it tapers off after 2 years.[4,5] Such slow release of fluoride from silicate cements has been shown to have an anticariogenic effect.[6,7] dependent primarily on the longevity of the release.[8] Recent research also has reported an antimicrobial effect of glass ionomer cements in vitro[9] and in vivo.[10,11] The objectives of our in vitro experiments were to determine the fluoride and acid release of several glass ionomer cements over time, and the relationship of the fluoride and acid to the antibacterial effects of these cements. (Pediatr Dent 16: 1994)

Methods and materials

Four glass ionomer cements, Shofu (Shofu Dental Corp., Menlo Park, CA), Ketac (Premier Dental Products Co, Norristown, PA), ProTech (Ormco, Glendora, CA), and TP (TP Orthodontics Inc, La Porte, IN) were mixed to manufacturer's specifications, and a 1.0-ml quantity of each cement was measured by filling microcentrifuge tubes (Marsh BioMedical, Rochester, NY) with cement. To determine the slow release of fluoride from these samples, they were removed from the tubes and immersed in 250 ml deionized water and left undisturbed in beakers at room temperature. After 24 hr a 2-ml aliquot of the deionized water was put aside for later fluoride analysis. This procedure was repeated every day for the next 30 days. The 120 aliquots collected in this fashion were diluted 1/1 (v:v) with ionic strength buffer and the fluoride in each sample was determined with a fluoride electrode (Orion Research, Cambridge, MA).

The antimicrobial effect of the same four glass ionomer cements against *S. mutans* (NCTC 10449), *S. sobrinus* (6715), *S. sanguis* (7865), and *A. viscosus* (OMZ) was examined immediately after mixing the cement and after aging the samples in deionized water for 1, 3, and 7 days. The cements were mixed and placed in a mold (Selfix 2234, Dura-Bilt, Chicago, IL) to create 2.5x7-mm samples. After the samples were allowed to set for 10 min, they were placed in beakers with 250 ml of deionized water and left undisturbed for 1, 3, and 7 days. The deionized water was discarded and replaced every 24 hr. Cultures were grown in modified Jordan's medium[12] at 37°C and adjusted to 80% transmittance (Spectronic 20, Bausch and Lomb, Rochester, NY) before being spread onto blood agar plates. Samples of each of the four glass ionomer cements, either freshly prepared or aged, were placed on the inoculated agar plates. Inhibition zones were measured after 2 days' incubation of the inoculated plates at 37°C.

Table. Antimicrobial activity, in mm inhibition zones on blood agar plates, of four ionomer cements after mixing or 1, 3, or 7 days

	Shofu	*Ketac*	*Protech*	*TP*
Immediately				
S. mutans	6.0	0.0	0.0	4.0
S. sobrinus	1.0	0.5	0.0	1.5
S. sanguis	6.5	2.5	2.0	3.0
A. viscosus	10.0	1.5	2.0	3.0
1 Day				
S. mutans	0.0	0.0	0.0	0.0
S. sobrinus	0.0	0.0	0.0	0.0
S. sanguis	1.5	0.0	0.0	0.0
A. viscosus	4.5	0.0	0.0	1.5
3 Days				
S. mutans	0.0	0.0	0.0	0.0
S. sobrinus	0.0	0.0	0.0	0.0
S. sanguis	1.0	0.0	0.0	0.0
A. viscosus	4.5	0.0	0.0	0.0
7 Days				
S. mutans	0.0	0.0	0.0	0.0
S. sobrinus	0.0	0.0	0.0	0.0
S. sanguis	0.5	0.0	0.0	0.0
A. viscosus	2.5	0.0	0.0	0.5

The pH of water in which each cement sample was aged was measured using a pH electrode (Orion Research, Cambridge, MA). After 2.5x7-mm cement samples were mixed they were immersed in 2 ml of deionized water for 1 day, 3 days, and 7 days (water replaced every 24 hr).

Results

The antimicrobial activity of the four glass ionomer cements was greatest immediately after the cements were mixed. Two of the freshly mixed cements, Shofu and TP, had the greatest zones of inhi-

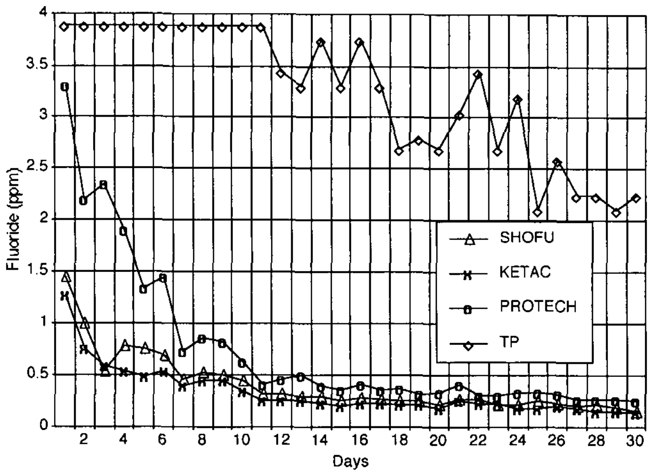

Fig 1. Fluoride release of four glass ionomer cements over a 30-day interval.

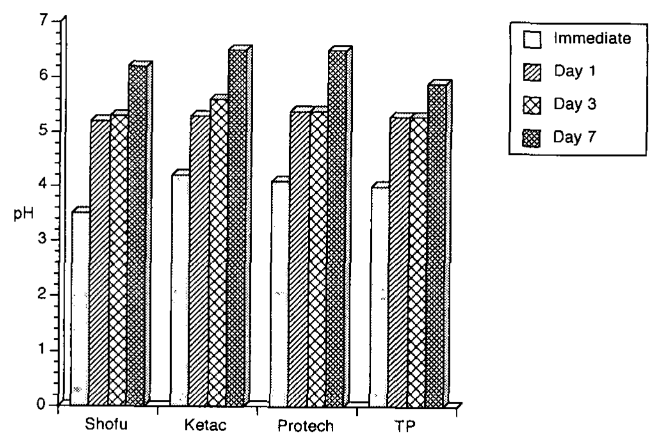

Fig 2. pH of deionized water in which glass ionomer cements were aged.

bition; and two oral isolates *S. sanguis* and *A. viscosus* were affected the most by the cements. After the cement samples were aged the antimicrobial effect was greatly reduced. Two of the four aged samples showed antimicrobial activity — primarily with the Shofu cement against *S. sanguis* and *A. viscosus* (Table). The fluoride release of the four glass ionomer cements over 30 days showed that the TP sample, consistently released more fluoride than the other samples. All samples released more fluoride at the beginning of the trial period (Fig 1). Similar to the fluoride release, the greatest acid release from the glass ionomer cements was found immediately after mixing. The immediately mixed samples consistently reduced pH more than 1 unit compared with the aged samples. The lowest pH was found in the Shofu sample (Fig 2).

Discussion

The results of this study suggest that the amount of fluoride released from glass ionomer cements per se may have little to do with inhibiting the growth of bacteria indigenous to the oral cavity. No relationship was found between the amount of fluoride released and the strength and duration of the antimicrobial action as measured by zones of bacterial inhibition. If the amount of fluoride released had a direct effect on the bacterial inhibition, the zones of inhibition would have persisted over time and would be largest for those samples that released the most fluoride.

Instead, it appears that the bacterial inhibitory effect of the glass ionomer cements used in this study is related to the acid released from the cement. A consistent relationship is found between the pH depression from the glass ionomer cements and the presence and size of zones of bacterial inhibition. The greatest acid release from the glass ionomer cements and the greatest antimicrobial activity is found immediately after mixing the cements. With aging, less acid is released from the cements and the bacterial inhibition diminishes. The smaller bacterial inhibition noted for *S. mutans* and *S. sobrinus* may be related to the well-known acid tolerance of these microorganisms.[13] This study, however, cannot rule out the possibility that the antimicrobial activity of the glass ionomer cements could be related both to the initial acid release and fluoride levels of the cement samples, since bacterial inhibitory effect of fluoride increases as pH decreases.[14]

Our findings confirm the results of other studies that show fluoride release from glass ionomer cements.[4,5] The antimicrobial action of these glass ionomer cements, however, appears short lived and not related to this fluoride release. Our results disagree with the implications of a study in which the antimicrobial effect of glass ionomer cements was only determined from freshly prepared samples.[9] They also do not support the conclusions that reduction of mutans streptococci levels adjacent to glass ionomer cements is due to fluoride.[10,11] Perhaps the differences between in vitro and in vivo conditions need further clarification. For example, it may be possible that a greater amount of fluoride is released from glass ionomer cements that are exposed to aqueous solutions, such as saliva, than those cements exposed to more viscous media such as agar. Nevertheless, our study does not support the hypothesis that fluoride release from glass ionomer cements has a long-term effect on bacterial viability. Additional investigations should be designed to explore conflicting findings between reports.

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Newborn's weight influenced by health care advice to mothers

Quality, rather than quantity of prenatal advice reduces risk of low-birth-weight babies

Women who say they received sufficient health behavior advice as part of their prenatal care are a lower risk of delivering a low-birth-weight infant, according to an article in a recent *Journal of the American Medical Association.*

Michael D. Kogan, PhD, National Center for Health Statistics, Hyattsville, Maryland, and colleagues interviewed 9,394 women who had live births in 1988. The women were part of the National Maternal and Infant Health Survey. The nationally representative survey was drawn from the 1988 vital records of all states except South Dakota and Montana. The purpose of the study was to examine the relationship between content of prenatal care and low birth weight.

The researchers concluded: "A major finding of the study is that women who reported not receiving all the recommended health behavior advice had a significantly higher risk (odds ratio 1.38) of delivering a low-birth-weight infant. Another major finding is that no significant differences in risk exist between women who reported receiving all the recommended initial prenatal procedures and those who reported not receiving all the procedures."

The women were questioned about whether they received advice on topics such as breast-feeding, reducing or eliminating smoking, not using illegal drugs, eating the proper foods during pregnancy, taking vitamins, and weight management.

The prenatal procedures they were asked about included pregnancy test, blood pressure measurement, urine test, blood test, recording of maternal weight and height, physical and/or pelvic examination, recording of health history, and ultrasound or sonogram.

The study says: "Significantly lower percentages of low birth weight were found for women who reported receiving advice on vitamin use, breast-feeding, proper weight gain, and avoidance of alcohol. Advice on proper diet and tobacco and drug use was not significantly associated with low birth weight. No significant differences in the percentage of low-birth-weight infants were observed among women who reported receiving or not receiving any of the initial procedures, except among those women having weight recorded."

The study also found a twofold risk of low birth weight for the infants of African-American mothers. Other factors influencing a higher risk of low birth weight were smoking, single marital status, first child, Asian ethnicity, less than 12 years of school, hypertension, and a prior adverse birth outcome.

The researchers conclude: "This study suggests that women who are at greater risk of adverse birth outcomes benefit the most from educational health care messages. These data suggest the need for continued and expanded medical education programs to increase provider awareness of the importance of health behavior advice as a critical part of prenatal services for all women, especially higher-risk women."