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Class II glass ionomer/silver cermet restorations and their effect on interproximal growth of mutans streptococci

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Abstract

The release of fluoride from glass ionomer materials is one of the most important features of this newly implemented material, and the remineralization effects of this phenomenon have been documented (Hicks and Silverstone 1986). This paper examines the effects of glass ionomer/silver cermet restorations on the plaque levels of interproximal mutans streptococci. Fifteen patients with Class II lesions in primary molars were selected for study. Interproximal plaque samples were obtained from each of the lesion sites and from one caries-free site approximal to a primary molar. One lesion was restored with composite resin to serve as a treated control to the glass ionomer/silver cermet (Ketac Silver, ESPE/Premier Sales Corp., Norristown, Pennsylvania) test site. A sound (unaltered) interproximal site served as the untreated control site. Plaque samples were collected before and at one week, one month, and three months post-treatment. Samples were serially diluted to enable colony counts of mutans streptococci. One week post-treatment counts showed that the glass ionomer/silver cermet restorations significantly reduced ($P < 0.05$) the approximal plaque levels of mutans streptococci. Conversely, the untreated and treated control sites did not exhibit reductions in approximal plaque levels of mutans streptococci. These results indicate that glass ionomer restorations may be inhibitory to the growth of mutans streptococci in dental plaque approximal to this restorative material in the primary dentition.

Introduction

The development of glass ionomer materials has allowed the implementation of several new restorative techniques into the armamentarium of pediatric restorative dentistry (Knight 1984; Donly et al. 1988; Swift 1988). With its ability to chemically adhere to tooth structure (McLean et al. 1985) and to release fluoride (Tveit et al. 1981; Derkson et al. 1982; Mount 1984; Wilson et al. 1985), glass ionomer can provide properties not inherent to any other restorative material. The addition of silver particles to glass ionomer has allowed the creation of a glass ionomer restorative material which may withstand the forces of occlusion over considerable periods of time (Stratmann et al. 1989). Potentially, fluoride release from glass ionomer materials could provide resistance to marginal carious breakdown via two distinct mechanisms. First, previous work has shown that glass ionomer restorations are more resistant to marginal carious breakdown in the Silverstone caries-like lesion system (Hicks 1986). Second, glass ionomer materials have been shown to exert inhibitory growth effects on streptococcal microorganisms (Tobias et al. 1985). This growth attenuation effect has been demonstrated on the surface of glass ionomer restorations (Bowen et al. 1984) and within cavity preparations when glass ionomer was used as a lining agent (McComb and Ericson 1987). Although this inhibiting effect has been shown to exist, no one has reported on the effect of glass ionomer restorations on adjacent plaque growth.

The purpose of the present study was to examine the influence of glass ionomer restorations on the interproximal plaque levels of mutans streptococci.

Materials and Methods

Fifteen children between the ages of 4 and 10 were selected for the study. These patients exhibited two Class II carious lesions on either the distal of the first or second primary molar, or on the mesial of the second primary molar. In addition, patients had at least one caries and a restoration-free surface on a contralateral primary molar.

The patient was anesthetized, and a Class II glass ionomer/silver cermet restoration (Ketac Silver, ESPE/Premier Sales Corp., Norristown, Pennsylvania) was placed into one of the two lesion sites. A standard amalgam preparation outline form was made (Waggoner 1988), and the glass ionomer restoration was placed after removal of the smear layer with 25% polyacrylic acid (Ketac Conditioner, ESPE/Premier Sales Corp., Noristown, Pennsylvania). The other lesion site

was restored with a composite resin restoration. Restorations were finished carefully, and an explorer and floss were used to verify smoothness of all margins.

Interproximal plaque samples were taken from each of the two lesion sites and from the caries-free site using sterile floss swords (Floss Swords, Caune and Caune, Soquel, California). Plaque samples subsequently were obtained one week, one month, and three months after treatment. The plaque samples were cut from the floss holder using sterile scissors and were placed into a test tube containing 2 ml of pre-reduced sterile transport fluid (0.1% peptone in 0.85 NaCl). Specimen tubes were placed into cracked ice and transported to the laboratory. Each specimen was sonicated for 30 sec to dislodge the plaque from the floss and to make a homogeneous suspension.

Serial tenfold dilutions of the plaque suspension were made using pre-reduced peptone saline, and 0.1 ml of each specific dilution was plated onto the surface of the medium using a sterile bent glass rod. The plated dilutions ranged from 10-1 to 10-6. All media were pre-reduced in an anaerobic chamber.

Specimens were plated onto 5% defibrinated sheep blood agar, Mitis Salivarius Agar (Difco, Difco Laboratories, Detroit, Michigan) (Gold et al. 1973), and Mitis Salivarius Agar with bacitracin and 20% sucrose (MSB) (Fig 1).

Plates were incubated anaerobically at 37°C for 72 hr, except for MSB plates which were incubated anaerobically for 24 hr at 37°C followed by incubation at room temperature aerobically for 24 hr to facilitate the formation of dextrans. Plates then were examined at a magnification of 7X using a wide field binocular dissecting microscope. Colony forming units were counted on

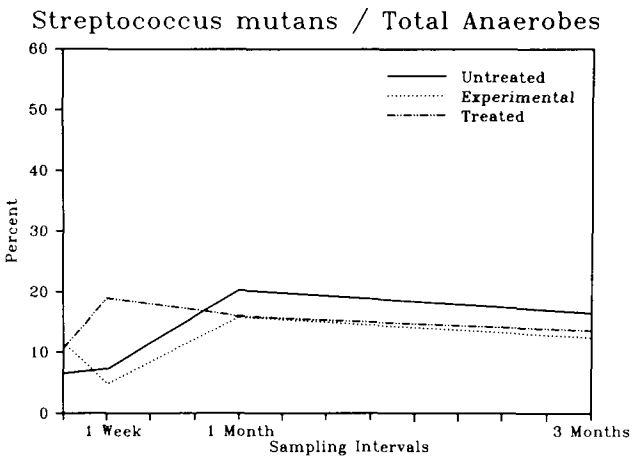

Fig 2. Ratio of percentage CFU mutans streptococci (Streptococcus mutans) to total anaerobes for all sampling periods. The dotted line depicts the glass ionomer treatment site; the interrupted line depicts the treated control (composite resin) site; the solid line depicts the untreated control site.

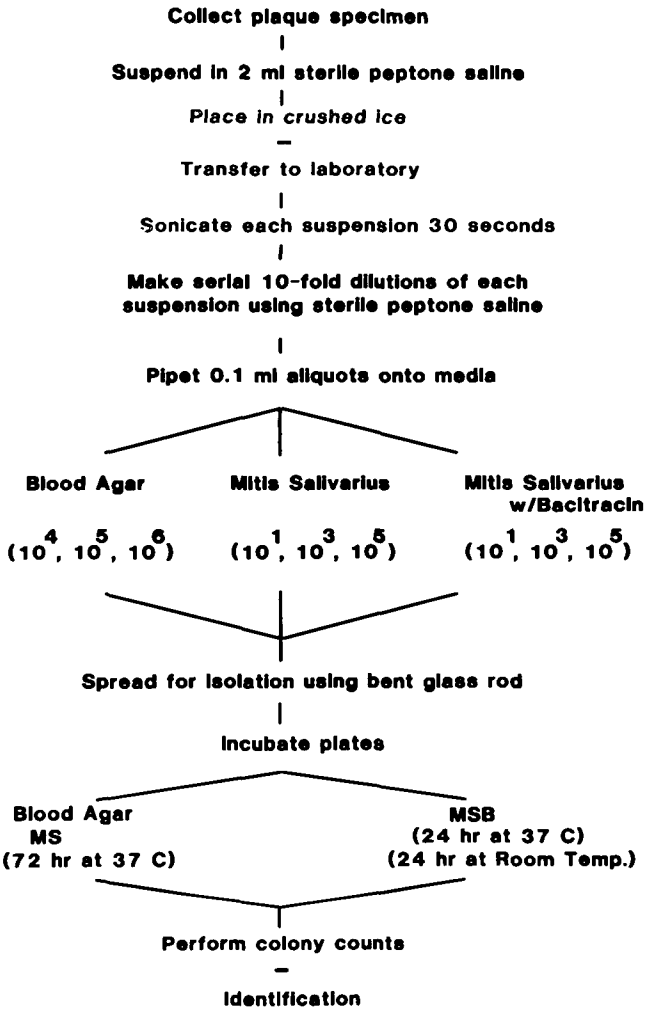

Fig 1. Diagram showing laboratory processing of plaque samples from collection through identification.

plates with 30 to 300 colonies. CFU counts were expressed as percentages in the following two categories: 1) mutans streptococci to total anaerobes, and 2) mutans streptococci to total streptococci. Regression lines were constructed to depict the rate of change in percentages within each of these three categorical tests between each sampling period.

Results

There was no statistically meaningful difference in the ratio of mutans streptococci to total anaerobes between the pretreatment and one-week values for the untreated and treated control groups (Fig 2, at left). Conversely, mutans streptococci decreased from 12 to 5% of the total anaerobic count ($P < 0.05$) (Fig 2) in the experimental glass ionomer group. The homogeneity of slopes test (Winer 1971) revealed the rate of change of growth to be different between the experimental and either of

the control groups for this one-week post-treatment period.

The reduction in mutans streptococci between the pretreatment and one-week period within the two control groups was not statistically meaningful ($P > 0.05$) (Fig 3, at right). Conversely, the mutans to total streptococci counts decreased significantly ($P < 0.01$) in the glass ionomer group over the first week of testing (from 45 to 20%). The rate of reduction of counts of mutans streptococci to counts of total streptococci also was significantly greater in the experimental group than either of the control groups for the first week period ($P < 0.05$).

At one month posttreatment, however, the experimental and control groups were at approximately the same level of mutans streptococci and stabilized after three months post treatment (Fig 2). Similarly, mutans streptococci to total streptococci stabilized at three months post treatment (Fig 3). Thus, plaque mutans streptococci levels relative to total streptococci and to total anaerobic organisms were reduced adjacent to glass ionomer restorations one week after treatment, but returned to levels similar to the control levels by one month (Figs 2 & 3).

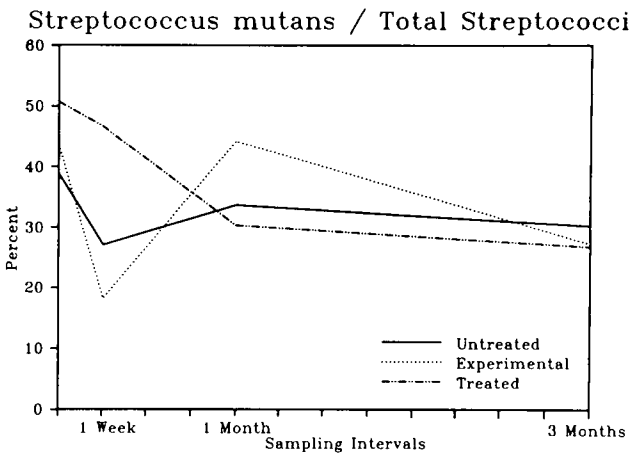

Fig 3. Ratio of percentage CFU mutans streptococci (Streptococcus mutans) to total streptococci for all sampling periods. The dotted line depicts the glass ionomer treatment site; the interrupted line depicts the treated control (composite resin) site; the solid line depicts the untreated control site.

Discussion

These data indicate that the glass ionomer/silver cermet restorations can exert a meaningful effect on the streptococci approximal to the restorations. Mutans streptococci specifically were impaired in their growth at the one-week postrestoration interval. This fact was evident — not only was the actual level of organisms reduced at one week, but also in the rate of change between the pretreatment and one-week samples.

A variety of in vitro studies also have demonstrated antibacterial activity of glass ionomer and other fluoride-containing restorative materials. Orstavik and Hensten-Pettersen (1977) determined that many different resin and silicate restorative materials exhibit antibacterial properties, and that diffusion of the antibacterial substance, be it fluoride or another substance, is critical in the retention of antibacterial effect. Similarly, in the present study the antibacterial effect was in accord with the time over which the fluoride is released from the glass ionomer/silver cermet material. McComb and Ericson (1987), in an in vitro study, examined the effect of high surface pH on antibacterial effect of lining cements (calcium hydroxide) compared with glass ionomer lining cement. They concluded that the higher pH of the calcium hydroxide lining materials did not contribute to the significant antimicrobial effect of the material, whereas the glass ionomer liner exerted significant antibacterial effect under in vitro conditions.

There was an apparent increase in percentages of mutans streptococci one week and one month post treatment in the experimental restorations in the present in vivo study. This numerical increase was not statistically significant, and likely represents increased plaque accumulation in the subjects one week after their dental visit. Care was taken not to offer any different recommendation to any of the subjects or their parents regarding oral hygiene habits.

Others (Forsten 1977; Tveit et al. 1981) have shown that fluoride release from glass ionomer materials is greatest immediately after placement of the restoration and gradually dissipates until asymptoting approximately three weeks after placement of the restoration. This concurs with our finding that at one month posttreatment the growth of mutans streptococci adjacent to glass ionomer restorations was comparable to that at control sites.

Although the results of the present study suggest that the effect of glass ionomer restorations on interproximal bacterial growth is exerted for a period of less than one month, it is important to note that a significant effect does exist, in that impairment of the growth of interproximal mutans streptococci can be clinically significant. Perhaps the duration of this effect can be modified to extend over a longer period. This fact, combined with the in vitro model of Hicks et al. (1986), showing that glass ionomer restorations create a marginal area less prone to recurrent decay, suggests that glass ionomer may exert a combined protective effect: i.e., 1) enhanced resistance to enamel surface demineralization, and 2) the direct impairment of plaque accumulation and growth of cariogenic microorganisms.

If there is a significant clinical effect of proximal glass ionomer restorations in vivo, then it will be important to look at mechanisms of optimizing this effect by selecting

the timing and location of restoration placement. Further studies are indicated to examine the influence of glass ionomer restorations on the growth of cariogenic organisms such as mutans streptococci as the glass ionomer materials are enhanced in their development to allow more long-term release of fluoride to the surrounding environment. If such materials can be altered to prolong the release of fluoride and thus extend the inhibitory effects on the growth or adherence of cariogenic microorganisms, then glass ionomers may become clinically important as a preventive restoration. Current investigations are examining the potential to replenish the fluoride reservoir within glass ionomer materials to allow continued release of fluoride for extended periods. The potential to "recharge" glass ionomer would allow subsequent investigation into the long-term effects of fluoride release from dental restorations.

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Artificial sweetener approved

Acesulfame potassium (pronounced "A-C-sul-fame"), approved in July by the FDA, is the newest sugar substitute available. Already used in many countries, the new sweetener will be called "Sunette" in the U.S. It is manufactured by Hoechst Celanese, Somerville, NJ.

Like aspartame, the additive is about 200 times sweeter than sugar. It has no aftertaste, contributes no calories, and is not metabolized by humans. Unlike aspartame, the substance does not break down in cooking.

The manufacturer claims it is noncarcinogenic. So far there are no claims of adverse health effects, but the additive has not been in general distribution long.