PEDIATRIC DENTISTRY/Copyright © 1991 by
The American Academy of Pediatric Dentistry
Volume 13, Number 1

Resistance of occlusal fissures to demineralization after loss of glass ionomer sealants in vitro

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Abstract

Seventy-one caries-free human occlusal fissures were used for this study. Twenty-two fissures were sealed with a glass ionomer sealant (Fuji Ionomer Type III® — G-C Dental Industrial Corp., Tokyo, Japan), 24 were widened with a diamond bur and sealed with the glass ionomer sealant, and 25 were left unsealed. After one week, the sealants were removed as completely as possible with a probe. All fissures were demineralized for seven weeks. Sections made from the fissures were examined with a polarizing microscope, and the depths of the fissure lesions were measured. The mean lesion depths for controls, sealed natural fissures, and sealed widened fissures were 143, 93, and 75 μm, respectively. A statistically significant difference was noted between the two experimental groups and the control group (no sealant). The results suggest that fissures sealed with glass ionomer are more resistant to demineralization than control fissures, even after macroscopic sealant loss. This may be the result of the combined effect of fluoride released by glass ionomer and residual material in the bottom of the fissures.

Introduction

The use of glass ionomer cement as a fissure sealant material has increased in recent years. So far, few studies of its efficacy have been reported, and the results of these studies have been conflicting. In the study by Williams and Winter (1981) using glass ionomer filling cement as a sealant, sealant loss was higher for glass ionomer than for resin, but there was no significant difference in caries incidence between teeth sealed with these two materials. McKenna and Grundy (1987) reported that the retention of glass ionomer cement was 93% after six months. However, studies by Shimokobe et al. (1986) and Boksman et al. (1987) using a glass ionomer material specially designed for fissure sealing, almost all sealants were lost within the first six months.

An interesting finding in the studies by Williams and Winter (1981) and by Shimokobe et al. (1986) was that glass ionomer sealants seemed to exert a cariostatic effect, even after they had disappeared macroscopically. Long-term retention may not be necessary if the material has anticariogenic properties that increase the caries resistance of newly erupted fissures. Fluoride released from glass ionomer and taken up by enamel (Forsten 1977; Retief et al. 1984; Swartz et al. 1984; Forss and Seppä 1990) may give prolonged protection. On the other hand, in our clinical study, microscopic examination of occlusal surfaces showing partial or total loss of sealants revealed that in most cases, residual material was observed in the bottom of the fissures (Torppa-Saarinen and Seppä 1990).

In the case of resin sealants, clinicians still debate whether or not it is necessary to widen narrow fissures before sealing (Meiers and Jensen 1984). As for glass ionomer, McLean and Wilson (1977) found that the filling cement could not penetrate fissures narrower than 100 μm, and recommended widening the fissures before sealing. Although a material with smaller particle size, such as glass ionomer developed for fissure sealing, seems to penetrate deeper into the fissures (Mount and Makinson 1978), widening might improve retention of glass ionomer sealants and provide longer protection. However, there is no information on caries resistance of widened fissures in the case of sealant loss.

The purpose of the present study was to examine whether fissures sealed with a glass ionomer cement designed for fissure sealing are less susceptible to demineralization than control fissures, even after the sealant has been removed. Another purpose was to study the effect of widening the fissures on resistance to demineralization after sealant loss.

Materials and Methods

Ten human third molars and 30 premolars were used for the study. All fissures were caries free by visual inspection. After extraction, the teeth were stored in 40% ethanol. The crowns were separated from the roots and bisected longitudinally, except for a few premolars with a very short occlusal fissure. The tooth halves were divided randomly into three groups. The fissures in the first group were left unsealed. The fissures in the second group were cleaned with a rotating brush and pumice, rinsed carefully, and sealed with glass ionomer sealant (Fuji Ionomer Type III® — G-C Dental Industrial Corp., Tokyo, Japan) using a small ballpoint instrument. Mixing was performed according to the manufacturer's instructions. When the sealant had lost its glossiness, it was covered with a varnish provided by the manufacturer. The fissures in the third group were widened with a narrow, flame-type diamond bur (diameter 0.5 mm) using ultra-high speed. Care was taken not to penetrate into the dentin. The occlusal surfaces were cleaned with pumice, rinsed, and sealed, as in the second group.

Each sample was stored for one week in a test tube containing distilled water. After that, the sealants were removed as completely as possible with a sharp probe, so that no residual material was left in the fissures macroscopically. All tooth surfaces (except for the fissures) were covered with acid-resistant wax (Prepon® — Bayer, Wetzlar, Germany). The samples then were immersed for seven weeks in 0.1 M lactic acid buffer, pH 4.3 in 5% carboxymetylcellulose to produce artificial fissure lesions. After demineralization, longitudinal sections were cut from the samples and the sections were ground to approximately 90 µm thick. The fissure lesions were viewed with a polarizing microscope (Leitz Diaplan® — Leitz, Wetzlar, Germany) and photographed. The depth of the lesion was assessed from the photomicrographs by measuring traverses running perpendicular to the enamel surface at six standardized points (Fig. 1), and the means of six measurements were calculated.

Data were analyzed using one-way analysis of variance for detecting significant differences and Scheffe's multiple comparison tests for pairwise comparisons.

Results

Seventy-one fissures were sectioned successfully. The mean depth of fissure lesions was 142.8 µm (SD 43.8) in control fissures (N = 25), 92.7 µm (50.6) in sealed natural fissures (N = 22), and 75.1 µm (35.7) in sealed widened fissures (N = 24, Fig. 2). The differences between the control and sealed fissures were statistically significant ($P < 0.01$), whereas the difference between natural and widened fissures was not significant. Figs 3 and 4 (see next page) show typical lesions in sealed and control fissures.

Residual sealant material was observed in six natural fissures and in four widened fissures. No lesion was seen under the residual material.

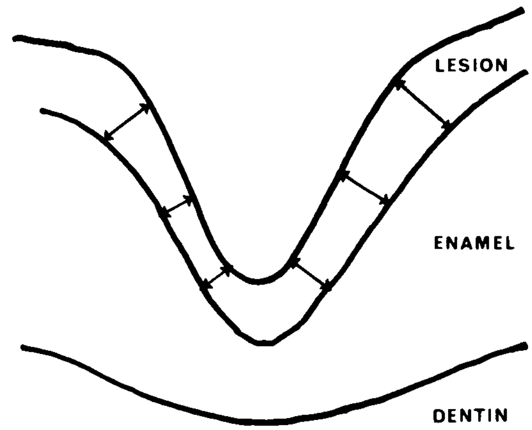

Fig 1. A diagram describing the measurement technique. The arrows show the points at which the measurements of lesion depth were made.

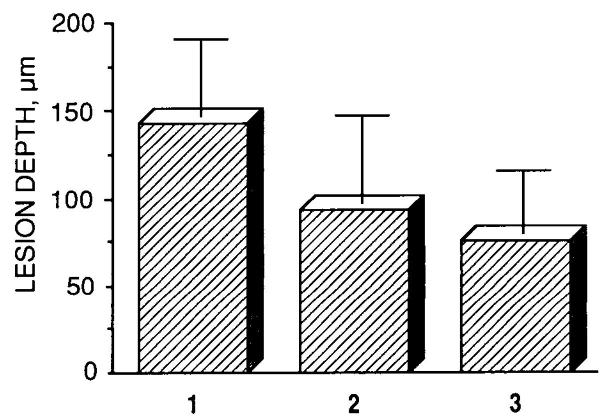

Fig 2. Mean lesion depth. I = control, 2 = sealed natural fissures, 3 = sealed widened fissures.

Discussion

The long-term retention of resin sealants is 60–80% (Mertz-Fairhurst et al. 1984; Simonsen 1987; Wendt and Koch 1988). Even though the initial retention rate is high (Weintraub 1989), regular control of surfaces sealed with resin sealants is necessary, at least during the first few years. For glass ionomer sealants, the retention rate appears to be lower, although long follow-ups have not been reported. However, the present results suggest that the fissures sealed with a glass ionomer sealant are more resistant to demineralization than unsealed fissures, even after the sealant appears to be lost. This may be the result of the combined effect of the increased fluoride level of the enamel or plaque, and residual

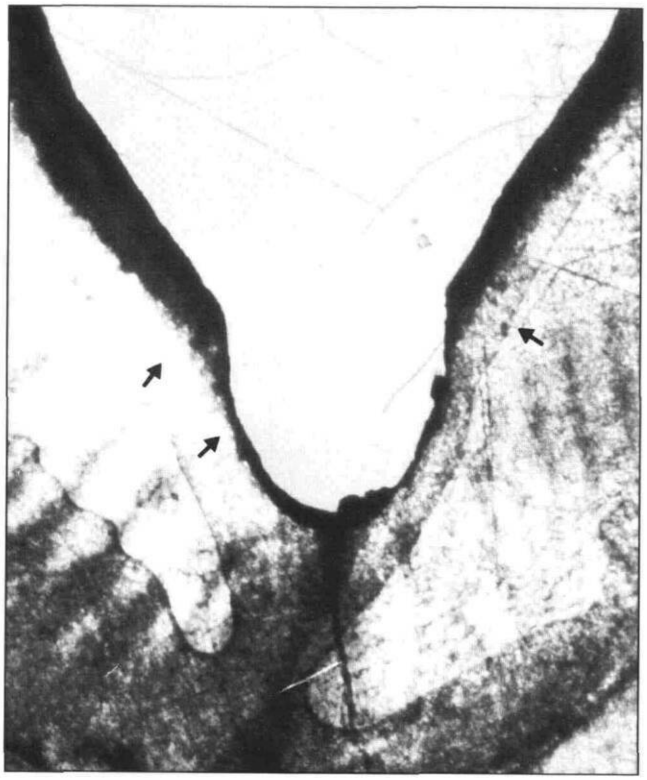

Fig 3. A typical fissure lesion in a widened fissure sealed with glass ionomer.

Fig 4. A typical fissure lesion in a control fissure.

material in the fissures. Although sectioning of the fissures probably removed most of the residual material, sometimes it was observed in the bottom of the fissures. This is probably often the case clinically after visible sealant loss, as observed in our previous study (Torppa-Saarinen and Seppä 1990).

The results also suggest that widening fissures does not make them more prone to demineralization than natural fissures, even when the sealant is lost macroscopically. A tendency to decreased demineralization in the widened fissures when compared to sealed natural fissures probably resulted from enhanced retention of residual material, although, because of sectioning, this could not be confirmed in the present study.

When considering the results, one must remember that an in vivo experiment does not fully reflect oral conditions. It also should be emphasized that although glass ionomer sealants increased the resistance to demineralization considerably, lesion formation was not inhibited completely. Thus, the results do not allow us to conclude that resealing of fissures in the case of sealant loss is never necessary with glass ionomers. However, glass ionomer may be a good alternative to resin sealants, at least when regular check-ups and rapid resealing of fissures showing sealant loss are not possible. Whether the fissures sealed with glass ionomer remain caries resistant for long periods can be assessed only in a long-term clinical study.

We are grateful to Ms Hanna Eskelinen for skillful technical assistance.

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Developing an office manual

Your dental office manual should be reviewed and updated periodically in order for policies to remain useful. An article in *General Dentistry* recommends the manual contain several sections, including:

The dental team
Philosophy of practice
The office team
Communication
Job descriptions
Emergencies
Safety (OSHA regulations)
Patient education
Promotion

Business office systems
Telephone procedures
Appointment control
Office forms and filing
Accounts receivable
Treatment plans and consultations
Recalls and correspondence
Insurance procedures
Collections

Chairside manual
Patient management
Infection control
The patient record
X-ray and photography
Plaque control
Organizational
Equipment maintenance
Supplies

Dental tray set-ups and procedures
Preventive dentistry
Restorative dentistry
Fixed prosthodontics
Oral surgery
Endodontia
Periodontia
Removable prosthodontics
Orthodontia

Employee manual
Evaluations
Training