

Scanning electron microscopy study of the fitting surface of fissure sealants

SHORT COMMUNICATION

Jean R. Jasmin, DCD Hubert van Waes, DMD
T.V. Vijayaraghavan, PhD, MS

Introduction

The bond strength between enamel and resin depends on achieving an etching pattern on the enamel surface which allows the resin to penetrate into the enamel and form tags. Silverstone et al. (1975) have described three basic etching patterns of human dental enamel using phosphoric acid solution. Type 1 etching pattern is related to the removal of the prism core material with the prism peripheries remaining relatively unaffected. In the Type 2 etching pattern, the peripheral regions of prism are removed, leaving prism cores relatively intact. The Type 3 etching pattern corresponds to a generalized enamel surface roughening.

Failures in sealant retention have been attributed to the following: contamination of the etched enamel with saliva and/or oil, residual organic or inorganic substances on the enamel surface, inherent properties of the sealant, improper handling of resin material, and/or excessive occlusal load on the sealant. In addition, fissure morphology (Galil and Gwinnett 1975a; Juhl 1983) and failure of etching liquid to reach enamel because of debris in the fissure have been postulated (Taylor and Gwinnett 1973; Burrow and Makinson 1990) and may help to explain a large number of sealant failures. The purpose of the present study was to observe enamel resin tags in teeth with sealed fissures using a replication technique.

Materials and Methods

Ten noncarious erupted, young, immature permanent teeth (9 third molars and 1 premolar) were selected for this in vitro study. The crowns were cleaned using a water slurry of fine pumice and a slowly rotating rubber cup. After thorough rinsing and air drying, the entire fissure region was etched for 30 sec with 37% phosphoric acid gel (Vivadent® Ets, FL-9494 Schaan, Liechtenstein). The teeth were rinsed immediately with water for 20 sec and dried with oil-free compressed air. A fissure sealant, Helioseal (Vivadent Ets, FL-9494 Schaan, Liechtenstein), then was applied following manufacturer's instructions. The sealant was allowed to penetrate into the fissure for 20 sec and polymer-

ized using a visible light curing unit (Demetron Research Corp., Danbury, CT). The sealed teeth were immersed in a 30% nitric acid solution for 6 hr to be dissolved and to obtain the sealant. The base (intrados) of the sealant served as a replica of the fissure. The replicas were cleaned for 3 min in a 9% sodium hypochlorite solution within an ultrasonic unit. Replicas then were rinsed with deionized water and mounted on aluminum stubs using a conductive colloidal silver adhesive. The specimens were left to dry in a desiccator for 2 hr. A scanning electron microscope (SEM) was used for observation of sealant replicas, which were coated with a conductive gold-palladium film.

Results

The results from the observation of sealant replicas obtained from sealed fissures are presented in the Table.

In all instances, the sealant penetrated deep into the fissures but did not consistently reach the bottom of the fissures. All specimens exhibited bubbles and gaps of different sizes and shapes in the depth (base) of the fissures (Fig 1, see next page).

All specimens showed a smooth fitting surface without visible resin tags. Impressions of Type 1, 2, and 3 etching patterns were observed in and around the fissures of every tooth (Fig 2, see next page). All cases showed numerous tags at the cuspal slopes and the upper side walls of the fissures.

Discussion

This SEM study was conducted on selected teeth with incomplete root formation (i.e., young permanent teeth). This choice was made so as to be as close as possible to the age of the teeth usually sealed in prac-

Table. Results from observation of sealant replicas

Tooth Number	1	2	3	4	5	6	7	8	9	10
Bubbles in the bottom of fissure	+	+	+	+	+	+	+	+	+	+
Debris in the fissure	+	+	+	+	+	+	+	+	+	+
Tags in the bottom of the fissure	—	—	—	—	—	—	—	+	—	—
Tags at cuspal slopes and fissure entrance	+	+	+	+	+	+	+	+	+	+

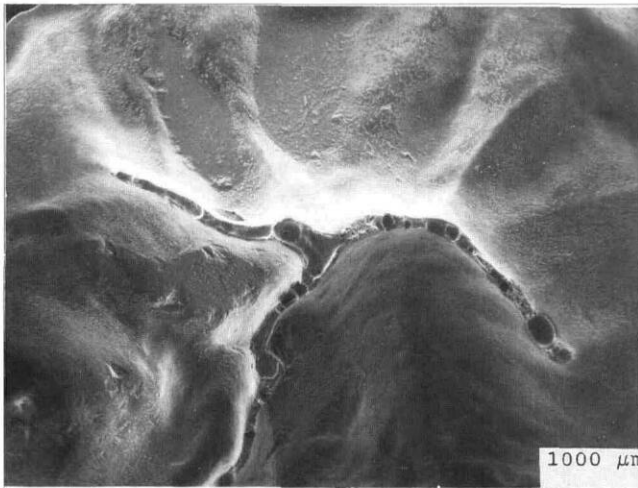


Fig 1. Scanning electron micrograph of the inner sealant's fitting surface (base) exhibiting air bubbles.

tice. Many of the earlier observations pertaining to this subject do not specify the age of the teeth studied (Gwinnett and Buonocore 1972; Taylor and Gwinnett 1973). It is known that human tooth fissure contents change with age and organic material undergoes mineralization processes (Galil and Gwinnett 1975b). This may influence the effect of acid conditioning on the enamel surface and the penetration and the retention of the sealant.

The technique of using sealants as replicas has been used previously (Silverstone 1975). The advantage of three-dimensional replicas vs. sections of teeth has been described by Galil and Gwinnett (1975a) and Juhl (1983). Silverstone (1975) used this technique to describe enamel surface etching patterns on the inner fitting surfaces of fissure sealants. He made no mention about the location of resin tags. Our study method was chosen to demonstrate the penetration of the sealant into the fissure and the location of resin tags under conditions similar to the clinical situation.

Our experiment confirms Silverstone's findings (1975; 1983) of the three types of etching patterns. Using the 33% phosphoric acid gel provided by the manufacturer for 30 sec, we found Type 1, 2, and 3 patterns on all teeth, with a random distribution of these types on each tooth surface replica (Fig 2). These results suggest that in young permanent teeth a short etching time of only 30 sec provides etching patterns similar to enamel surfaces etched for 60 sec. They also corroborate previous reports (Garcia-Godoy and Gwinnett 1987; Burrow and Makinson 1990) which demonstrated that 33% phosphoric acid-gels as used in our study are as effective as a 35% phosphoric acid solution.

All sealant replicas show gaps, mostly located in the base of the fissures (Fig 1). Some of the gaps in the resin

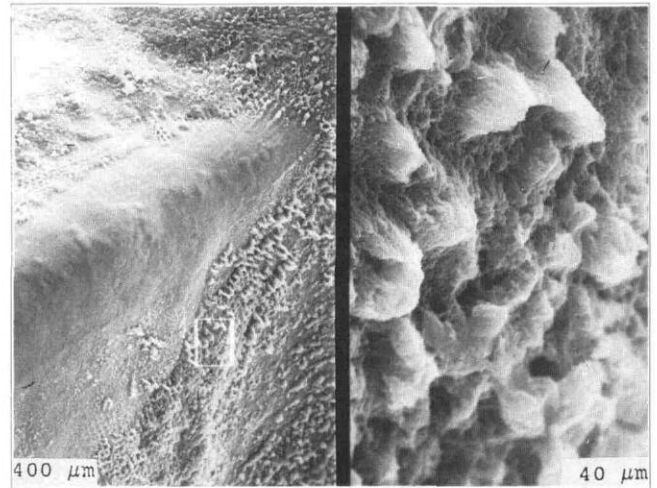


Fig 2. Fitting surface of the sealant showing smooth tag-free area at the depth of the fissure.

were spherical (Fig 1), indicating the entrapment of air bubbles. This has been noted previously (Gwinnett and Buonocore 1972; Galil and Gwinnett 1975b). Other voids with more irregular shape could correspond to impressions of organic and inorganic substances which were present in the fissures and were incorporated subsequently in the sealant. These findings are similar to observations of Taylor and Gwinnett (1973) and Buonocore et al. (1990). This observation emphasizes the difficulty involved in removing fissure contents using pumice and etching acid.

Nine of 10 samples failed to demonstrate resin tags in the deepest part of the fissures (Table). Fig 2 shows the demarcation line between areas with tags present and areas without tags. This demarcation is typical for all cases and indicates that resin tags do not appear to be confined only to the inclined cuspal slopes as shown by Gwinnett et al. (1982), but also occur on the upper part of the fissure. The procedure of waiting 20 sec after sealant application prior to polymerization may have contributed to a better penetration of the resin into the fissures.

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Dr. Jasmin is professor and chairman, Department of Pedodontics, UFR d'Odontologie, Nice, France; Dr. van Waes is assistant professor, Department of Pedodontics, Zahnantliches Institut, Zurich, Switzerland; and Dr. Vijayaraghavan is assistant professor, Department of Dental Material Science, New York University College of Dentistry, New York, NY. Reprint requests should be sent to Dr. Jean R. Jasmin, U.F.R. d'Odontologie, Parc Valrose, Avenue Joseph Vallot, 06034 Nice Cedex, France.

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Reducing glove tears and sharp injuries in surgery should help control HIV and other infections

Strategies to reduce glove tears and sharp injuries to surgical personnel should help prevent exposure to HIV and other blood-borne pathogens in the operating room, according to a study published in the *Journal of the American Medical Association*.

“Exposure to blood remains a significant risk for operating room personnel,” according to James G. Wright, MD, MPH, FRCSC, of the Department of Medicine, Yale University School of Medicine, New Haven, CT, with colleagues. “Knowledge of the specific mechanisms of exposure should help lead to effective specific strategies for prevention that could be incorporated into or could replace universal precautions.”

The authors conducted a study on the mechanisms of sharp injuries, glove tears, and gown leaks among surgical personnel. They studied 2,292 surgical procedures performed from February to May 1990 at Yale-New Haven (Connecticut) Hospital. Exposure information was collected by an experienced OR nurse immediately after a reported exposure.

The authors found the rate of glove tears was 10.9 per 100 procedures. For sharp injuries, it was 3.1 per 100 procedures; and for gown leaks, it was 0.5 per 100 procedures.

They found 249 glove tears and 70 sharp injuries. In the 81 known-mechanism glove tears and 70 sharp injuries, 112 (74%) were self-inflicted. There were 12 gown leaks reported, 11 of which occurred when the surgeon or assistant was reaching deeply into an abdomen filled with blood or fluid.

In 230 of the glove tears (92%), personnel were wearing single gloves. Visible skin contact with a patient's blood occurred in 156 tears (63%). The mechanism of the tear was identified only in 81 (33%) of tears. Most of the tears occurred at the fingertips.

Of the 70 sharp injuries, needles were the cause of 47 (67%) injuries (usually during suturing); another seven (10%) were caused by scalpels; and 16 (23%) by other instruments, they found. The injury caused bleeding in 56 (80%) of the cases.

The authors recommended wearing double gloves to reduce the possibility of glove tears, and wearing elbow-length gloves to reduce exposure to blood-borne pathogens during gown leaks.

They suggested strategies for preventing sharp injuries, including eliminating the activity of the injuring instrument or the injured hand. “Before any preventive strategy is recommended, however, the compliance and efficacy of the countermeasure, and the effect on patient care and surgical proficiency must be considered,” the authors noted.