Microleakage of sealants after conventional, bur, and air-abrasion preparation of pits and fissures

S. Hatibovic-Kofman, DDS, MDSc, PhD GZ Wright, DDS, MSD, FRCD(C) Ian Braverman, DDS

Abstract

Purpose: *The aim of this study was to compare the microleakage of unfilled and filled sealants after conventional, bur, and air-abrasion tooth preparation.*

Methods: *Seventy-two extracted molars were randomly divided into three groups. In group 1, 24 teeth were prepared by pumicing and acid etching with 37% phosphoric acid. In group 2, 24 teeth were prepared with a 1/4-round bur in a low-speed handpiece and then acid etched. In group 3, 24 teeth were prepared by high-speed (160 PSI) microabrasion using 50 μ α alumina particles in a KCP 2000 machine. In each group, 12 teeth were sealed with a filled sealant and 12 teeth with an unfilled sealant. All the teeth were stored in artificial saliva for 7 days and thermocycled for 2000 cycles. Teeth were then sealed apically and coated with nail varnish 1 mm from the margins and stained in 1% methylene blue for 24 h. Each tooth was sectioned in three locations and ranked (0–3) for microleakage.*

Results: *There were 216 sections and 66% showed no leakage.*

Conclusions: *Chi-square statistical analysis of the data led to the following conclusions: 1) superior results were obtained when the tooth surfaces were prepared by a bur, 2) conventionally and KCP 2000-prepared tooth surfaces yielded similar results, and 3) the unfilled sealant was superior to the filled sealant. (Pediatr Dent 20:3 173–76, 1998)*

Microleakage or marginal leakage may be defined as the ingress of oral fluids into the space between the tooth and restorative material.[1] The ability of a sealant to prevent microleakage is important because microleakage may support caries below the sealant.[2,3] Pits and fissures that are successfully sealed may prevent or arrest early developing occlusal lesions.[2–7]

Many studies have examined microleakage of sealants placed by the conventional method of acid etching the enamel. All show some microleakage but results vary.[8–18] A limited number of studies have compared microleakage of sealants using other methods of tooth preparation. For example, Boj et al. found no statistically significant difference in microleakage between sealants applied after conventional pumicing and bur preparation of the pits and fissures.[19] Comparing sealants on tooth surfaces prepared conventionally with those prepared by air abrasion, Eakle et al.[20] found statistically less microleakage in the former group.

Considering the importance of sealant integrity, the purpose of our study was to compare the microleakage of pit and fissure sealants after conventional, bur, and KCP 2000 preparation of the pits and fissures and the microleakage of unfilled and filled pit-and-fissure sealant materials using the three methods of tooth preparation.

Methods

Seventy-two extracted human maxillary and mandibular molars with intact occlusal surfaces were used in the study. After extraction, the specimens were cleaned with prophylaxis paste and tap water and refrigerated in a thymol solution. The teeth were divided randomly into three groups of 24 teeth each. Group 1 teeth were prepared by acid etching according to the manufacturer's instructions. In group 2, the pits and fissures were opened with a 1/4-round bur in a low-speed handpiece to an approximate diameter of the bur and then acid etched. In group 3, the pits and fissures were prepared without acid etching by KCP 2000 (American Dental Technologies, Inc., Troy, MI) which was set at 160 PSI for microabrasion using 50-μ α alumina particles according to the manufacturer's instructions.

Each group of 24 was randomly divided into two subgroups of 12 teeth each. In subgroup A, an opaque unfilled sealant was used (Delton,® Ash/Dentsply, York, PA). The B subgroup used a filled sealant (Primashield,® L.D. Caulk, Milford, DE).

To simulate oral conditions, the sealed teeth were immersed in artificial saliva in plastic containers for 7 days in an incubator at 38°C. The artificial saliva was prepared and modified according to the method described by

Shellis[21] and Kazanji and Watkinson.[22] Prior to testing, teeth were thermocycled for 2000 cycles at 6° and 47°C.

The teeth were dried and coated with two coats of nail varnish, aluminum foil, and red utility wax. Only the sealant and about 1 mm of the surrounding tooth structure was exposed. The teeth were immersed in a 1% solution of methylene blue for 24 h at 37°C. Afterward, the teeth were rinsed with tap water and sectioned with a water-cooled diamond disc mounted on a low-speed Isomet (Buehler, Ltd., Lake Bluff, IL) saw in a buccolingual plane through the sealant. Three sections were made of each specimen. Each section was examined at random under 4x magnification using a stereo zoom microscope. One examiner, who was calibrated by assessing 45 sections before this investigation and who was unaware of the type of restorative material, evaluated the sections according to a method described by Överbö and Raadal.[16] The method is as follows:

1. Score 0–No dye penetration
2. Score 1–Dye penetration restricted to the outer half of the sealant
3. Score 2–Dye penetration to the inner half of the sealant
4. Score 3–Dye penetration into underlying fissure

The Chi-square test was used to determine whether there was a significant difference in microleakage between conventional, bur, and air-abrasion methods and whether there was a difference between an unfilled and filled sealant leakage.

Results

A total of 216 sections were examined for microleakage. The dye penetration for all sections is shown in Table 1. Interestingly, when all sealants' sections are considered, 66% had no leakage. Minimal microleakage, i.e., dye penetration limited to the outer half of sealants, occurred in 55 of 216 sections (26%).

The microleakage scores of sealants according to the method of preparation are expressed in terms of percent dye penetration in Figure 1. Bur-prepared sealants showed significantly less microleakage ($P < 0.05$) than conventionally or KCP 2000-prepared sealants. However, there was no statistically significant difference in microleakage ($P > 0.05$) between conventionally and KCP 2000-prepared sealants. In Figure 2, penetration according to type of sealant material is shown. The unfilled sealant sections showed significantly less microleakage ($P < 0.05$) than filled sealants, regardless of the method of tooth preparation.

The three sections for each tooth were also grouped to determine the number of sealants with no leakage (Table 2). Considering these data, 83% (10/12) of the bur preparations with unfilled sealants demonstrated no leakage. The air-abrasion preparations with filled sealants yielded the worst results as only one sealant had no microleakage. When all sealants for each tooth are considered, only 29 of 72 teeth (40%) had no leakage in any section.

Table 1. Microleakage Scored under All Sealant Sections

	Dye Penetration							
	Unfilled Sealant				*Filled Sealant*			
Method of preparation	0	1	2	3	0	1	2	3
Conventional	23	11	2	0	17	17	2	0
Bur	34	2	0	0	28	3	0	5
Air abrasion	25	7	2	2	16	15	1	4

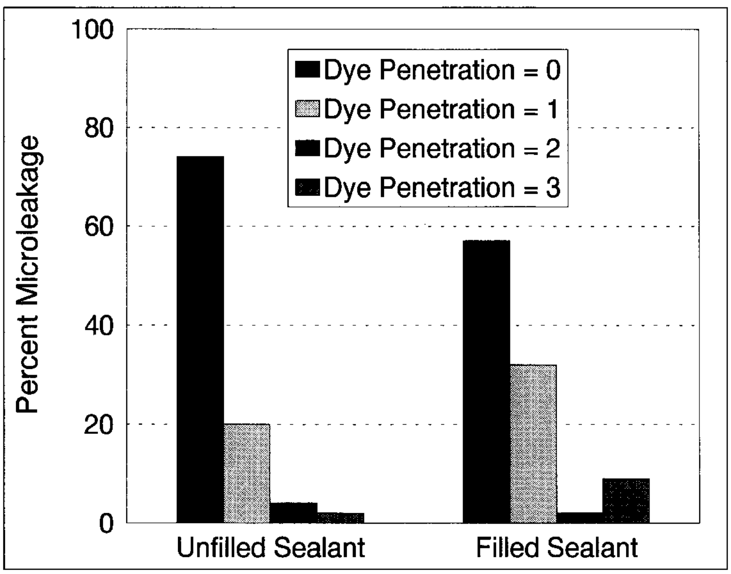

Fig 1. A comparison of dye pentration by preparation method.

Discussion

The major finding of this study is that the bur preparation followed by acid etching produced sealants with less microleakage than conventional or air-abrasion tooth preparations. Several reasons can be offered for the finding. The bur preparation opens a pit or fissure. Superior sealant adaptation and penetration are likely, due to the widening and deepening of the pits and fissures and the elimination of organic material, plaque, and a very thin layer of prismless enamel.[29] Previous studies have also shown that even in those cases where all or part of the pits and fissures were penetrated by the sealant, there may be poor resin adaptation due to lack of enamel conditioning or air entrapment. In these studies, scanning electron photomicrographs show a lack of resin tags and the presence of a smooth surface in the deeper portions of the sealant fitting surfaces.[24–28] The

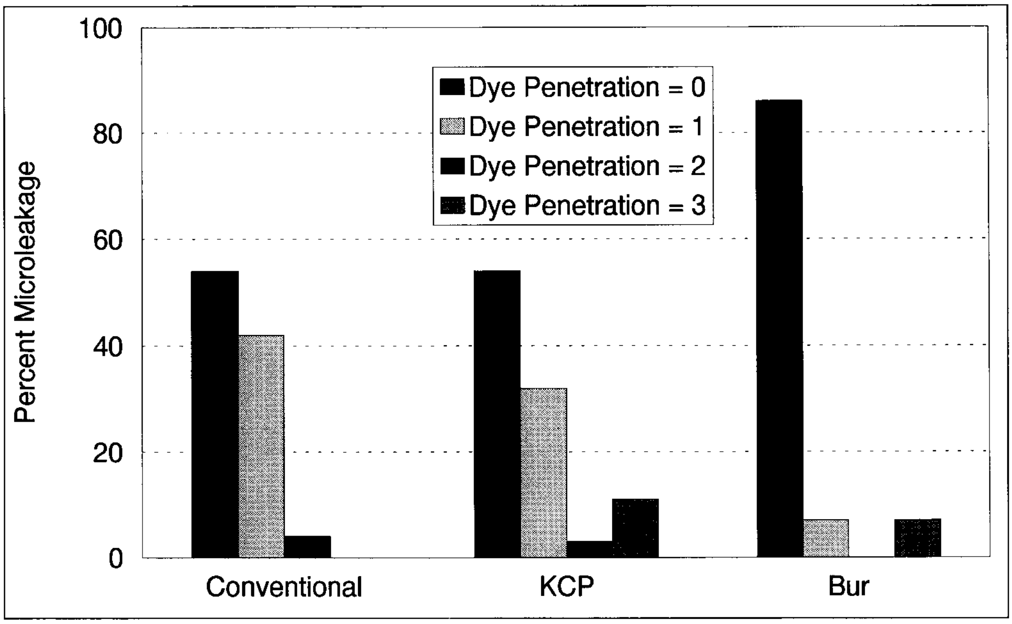

Fig 2. A comparison of dye pentration by preparation method.

TABLE 2. NUMBER OF SEALANTS WITH NO LEAKAGE

	Sealant Type	
Method of Preparation	*Unfilled*	*Filled*
Conventional	3	2
Bur	10	7
Abrasion	6	1

wider entry created by the bur preparation enhances sealant adaptation.

In contrast to our study, Boj et al.[19] found no statistical difference in sealant microleakage after bur or conventional preparation. The difference in findings may be due to different enamel preparations. Boj et al. used a 1/4-round bur and a Sorensen pointed bur in a high-speed handpiece. The present investigation used only a 1/4-round bur in a low-speed handpiece. Recently, Halterman et al.[30] found that instrumentation varied and a large range of depths are used. According to their results, 50% of pediatric dentists always use a light "sweep" of the grooves (< 0.5 mm) without necessarily removing all staining or "chalkiness" in the grooves. The effect of different preparation techniques needs further investigation.

The greater leakage in conventional pumice preparations may be attributed to several causes. Pumice prophylaxis does not completely and consistently remove debris from pits and fissures.[23–25] Even after acid etching and rinsing, debris may remain in the pits and fissures, preventing enamel conditioning and decreasing resin penetration. Any remaining pumice could also prevent acid and sealant penetration into the pits and fissures.[25]

Clinical evidence tends to support the findings of this investigation. In a controlled, 6-year clinical study by Shapira and Eidelman,[29] bur-prepared sealants had 88% retention rates compared to a 66% retention rate for conventionally prepared sealants. The 66% retention is similar to other clinical investigations. It can be hypothesized that the greater retention can be attributed to the enlargement of the pits and fissures which produces a greater surface area for bonding, the use of a thicker layer of sealant which would be more resistant to wear, and using sealants with less microleakage.

Although our study indicates superior results with bur preparation, there was no statistical difference between conventionally and KCP 2000-prepared sealants. The finding differs from the microleakage study of Eakle et al.[20] In their investigation, much more dye penetration occurred in the air-abrasion sealants than the acid-etch sealants. They concluded that air abrasion produces a roughened surface but lacks the seal obtained with acid etching.

We also found that unfilled sealants had less microleakage than filled sealants. The latter has a higher filler load and is thus more viscous. The higher viscosity may cause poorer adaptation of sealant to enamel and incomplete penetration to the bottoms of the pits and fissures, resulting in decreased retention. More fluid resins may penetrate fissures more deeply and spread more rapidly over the surface.[14]

Microleakage studies comparing unfilled and filled sealants display a dichotomy of results. Our results are consistent with findings of Bryant and Martin which showed statistically less microleakage in the less viscous than the more viscous resin.[33] However, other studies showed no statistically significant difference in microleakage between Delton and Prismashield sealants.[18, 19]

Investigations of this type should guide clinical practice. However, the inconsistency of results is confusing. Different testing substances make comparison between studies difficult. For example, Boj et al.[19] used basic fuchsin while we used methylene blue. An opposite result was obtained by Sams et al.[32] They observed no dye penetration using 0.5% basic fuchsin dye in any of the teeth cleaned with air abrasion and acid etched. The clinical relevance of these studies has also been questioned because dyes such as methylene blue, basic fuchsin, and silver nitrate have small molecules.[1] There is also no proof that sealants penetrated by dyes, especially on the outer surfaces, fail clinically. To make microleakage investigations more meaningful in the future, a link between sealants and their clinical performance must be established.

Conclusions

Based on the conditions in our study, the following conclusions were made about sealant microleakage.

1. Superior results were obtained when the tooth surfaces were prepared by a bur.
2. Conventionally pumiced and KCP 2000-prepared tooth surfaces yielded similar results.
3. The unfilled was superior to the filled sealant.

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Dr. Hatibovic-Kofman is assistant professor, Orthodontics and Paediatric Dentistry, Dr. Braverman was a senior dental student, and Dr. Wright is professor and chair, Orthodontics and Paediatric Dentistry, all of the Univeristy of Western Ontario, London, Ontario, Canada.

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