

## Compressive strength of fissure sealant applied over cavities

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### Abstract

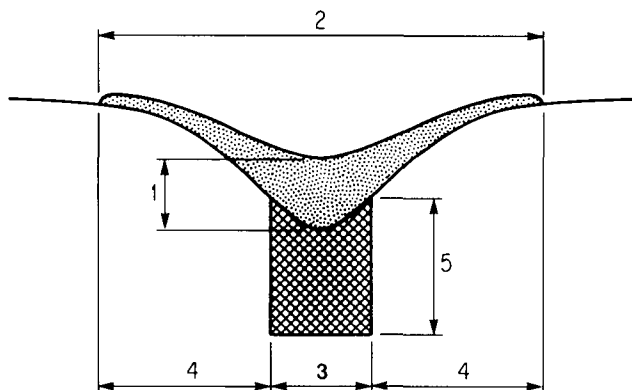
*This study examined the influence on sealant strength of sealant thickness and size of opening to be bridged when fissure sealant was applied over cavities. Few differences in groups were found when thick and thin sealants were placed over 1.0, 1.4, and 1.8 mm cavities and tested by compression until fracture. Sealants placed over cavities were much weaker than sealants placed over sound enamel.*

**F**issure sealant has been used successfully to prevent dental caries in pits and fissures.<sup>1-4</sup> Because of its success, clinical studies have been performed to examine the effect of placing sealants over carious lesions.<sup>5-8</sup> If that technique proves to be successful and an unprepared carious lesion is covered therapeutically with sealant, the success of the covering theoretically will be dependent on a number of variables including the thickness of the sealant, the total extent of coverage of the sealant material on etched enamel, the size of opening into the cavity, the amount

of undermined enamel, and the cavity depth (Figure 1). Of these variables, the cavity depth would appear to be unimportant and, in a typical situation with minimal or moderate caries, the extent of sealant coverage on etched enamel would seem to be so much greater than the size of the opening that the extent of coverage also would appear to be relatively unimportant. Of all the variables, the thickness of the sealant material and the size of the opening to be bridged would be of relatively greater importance. This study was conducted to examine the influence of those variables on sealant strength when sealants were subjected to compression testing.

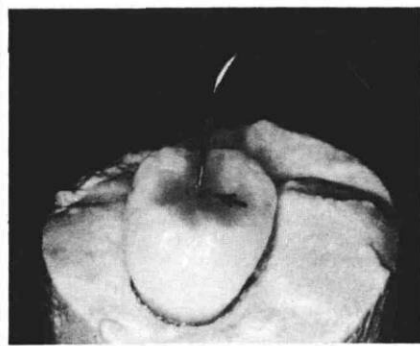
### Methods

One hundred and sixty extracted noncarious permanent third molar teeth were divided into eight groups with 10 teeth in each group (5 maxillary and 5 mandibular, Table 1). Two groups with no cavities placed were used as controls, and in the remaining teeth a single cavity was placed in the central pit on the occlusal surface. Each tooth was mounted in a cylinder of cast stone approximately 1¼" long by ¾" diameter and each group received one of three different size cavity openings (1.0, 1.4, and 1.8 mm) in two different shapes (round or triangular). The cavities were prepared with #2, 4, or 6 round carbide burs<sup>a</sup> used at high speed with water coolant. The round cavity was the same diameter as the bur (Figure 2), whereas the triangular cavity began as the round cavity with three extensions, one-half the diameter of the bur, which were added to simulate a cavity placed in a central pit and slightly extended into fissures mesially, distally and buccally, or lingually (Figure 3). The tooth sample was subdivided equally so that for each test condition two different amounts of sealants were

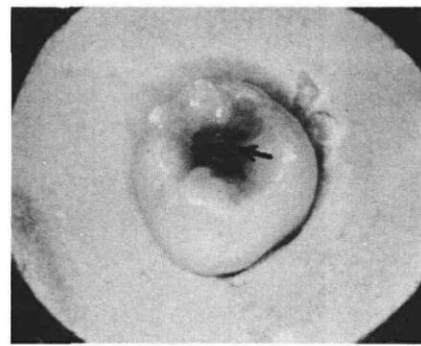


**Figure 1.** Variables affecting strength of sealant applied over cavities. Thickness of sealant (1). Extent of coverage of sealant material on etched enamel (4 or area 2 minus area 3). Width of cavity (3). Depth of cavity (5).

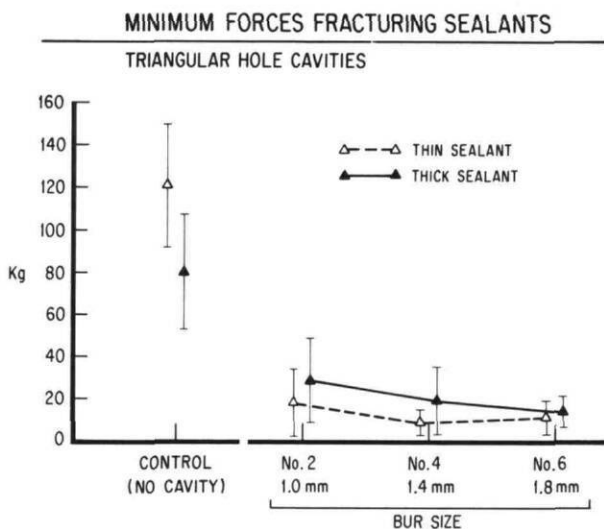
<sup>a</sup> S.S. White Co., Philadelphia, PA.



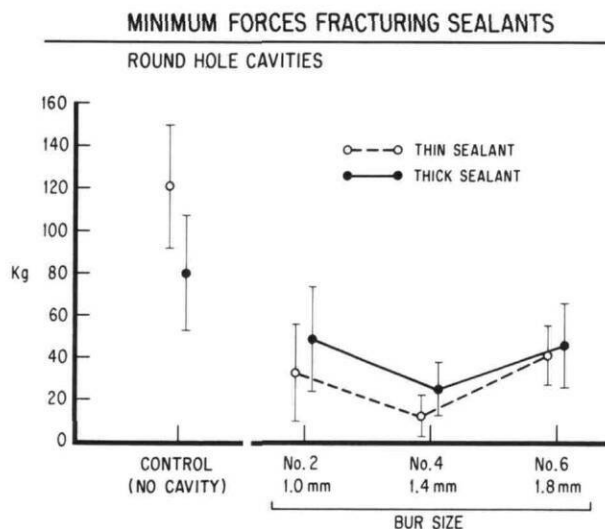
**Figure 2.** (left) Mounted tooth—note small round hole filled with brown rubber impression material covered with sealant. Explorer point indicates area of penetration of Instron machine round point.



**Figure 3.** (right) Mounted tooth — note large triangular hole filled with brown rubber impression material covered with sealant. Arrow indicates depression in sealant surface caused by testing with the Instron machine penetration point.



**Figure 4.** Mean and standard deviation of the minimum forces required to fracture the sealants in the study groups of teeth with no holes (control group) and 1.0, 1.4, and 1.8 mm triangular hole cavities.



**Figure 5.** Mean and standard deviations of the minimum forces required to fracture the sealants in the study groups of teeth with no holes (control group) and 1.0, 1.4, and 1.8 mm round hole cavities.

used. After cavity preparation, each cavity was filled to the surface with a small amount of rubber impression material (Kerr Permalastic<sup>b</sup>) to simulate a soft carious lesion and prevent the sealant material from flowing into the cavity. The rubber material was used instead of cotton which would have absorbed some of the sealant or wax and contaminated the enamel surface.

Following the manufacturer's instructions, tinted Delton<sup>c</sup> sealant was applied to the teeth. These had been cleaned with a rubber cup and slurry of pumice, etched for 60 seconds with 37% phosphoric acid, washed, and dried. Either a thin sealant (corresponding to 5 mm of sealant material in the Delton dispensing tube) or a thick sealant (8 mm of sealant in the tube) was placed.

All teeth were stored for two days in a humid environment and then subjected to compression test-

<sup>b</sup> Sybron/Kerr Co., Romulus, MI.

<sup>c</sup> Johnson & Johnson Dental Products Co., East Windsor, NJ.

ing. Each sample was compressed on an Instron testing Machine (Model 11-15)<sup>d</sup> with a 1/8" round penetration point until fracture. The teeth were positioned so that the force would be applied to the center of the cavity and directed parallel to the long axis of the tooth — approximately at right angles to the surface of the sealant.

## Results

Following compression, the sealants usually failed by penetration of the point into the sealant surface, although a piece of the sealant occasionally was dislodged from the tooth surface. The minimum amounts of force required to fracture the sealants over the triangular-shaped cavities appear in Figure 4. In the 60 samples, the mean forces ranged from 9.3 to 27.8 kg for the six different groups. Slight, statistically significant differences were found between the groups

<sup>d</sup> Instron Corporation, Canton, MA.

with thick sealant and those with thin sealant, and between the groups with different size holes (F analysis of variance test at the 0.05 level of significance [F = 5.15 and 3.75]). However, when the Tukey test was used to ascertain which groups in the 2 × 3 analysis were different, only the groups with thick sealant over the small hole and thin sealant over the middle or large size holes were different. Consequently, there were no significant differences across groups in regard to bur size or sealant thickness. By comparison, the control groups with no holes placed sustained fracture of the sealant with a mean force of 121 kg applied to the thin sealant and 80 kg applied to the thick sealant, and the mean differences were statistically significant when tested with the t-test at the 0.05 level of significance (t = 3.2).

Figure 5 shows the mean amounts of force required to fracture the sealants placed on round hole cavities. These ranged from 11.9 to 48.6 kg and the differences were statistically significant when tested with the F test at the 0.05 level of significance (thickness, F = 4.52; bur size, F = 13.27). The Tukey test demonstrated significant differences among all three groups covered with thick sealant but only between 1.4 and 1.8 mm holes with the thin sealant. In regard to sealant thickness, only the groups with the 1 mm hole demonstrated a significant difference between thin and thick sealant.

Relatively greater forces were required to fracture the sealants covering the largest size round holes. In order to verify those values, an additional 20 extracted third molar teeth with 1.8 mm round holes were tested, and these produced similar values. It remains an enigma as to why the sealants over the largest round holes were stronger than those over the smaller ones. With the exception of this aberration in the data, and within the parameters studied, there was little significant difference between groups in regard to shape and size of cavity or sealant thickness.

## Discussion

These findings demonstrate little differences between groups when thick or thin sealants were placed over cavities of two different shapes and three different sizes. There was relatively small between-group variance as compared with the within-group variance. A factor contributing to the within-group variance might be the relatively inaccurate method of determining thickness. Although two specific volumes of sealant were used, the actual sealant thickness varied due to anatomy of the teeth. Some teeth had small occlusal tables, whereas others had large

surfaces with many fissures. Although there would have been less variation if the relatively flat buccal surfaces of the teeth had been used for testing, the occlusal surface was chosen to approximate the clinical situation more closely. Another factor contributing to the variance may be the position of the penetration point as each sample was compressed. Although the point was placed directly over the cavity in the tooth, it is possible that small variations in point placement contributed to some of the within-group variance.

In this study an unfilled sealant was used. A filled material which might have yielded stronger sealants with greater differences between groups also should be tested.

These findings demonstrate that unfilled sealants over cavities are much weaker than those sealants over intact occlusal surfaces. Sealants over cavities fractured with approximately ¼ to ⅓ the amount of force required to fracture the sealants over surfaces without cavities. However, it is not yet known how strong sealants would have to be in order to function in the mouth, nor is it known what amount of undermined enamel would affect sealant strength. More importantly, the appropriateness of compression testing to simulate forces in the oral cavity still must be established.

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1. Bagramian RA: Five-year sealant results in a school-based dental program, IADR Program and Abstracts, no 1250, 1981.
2. Houpt M, Shey Z: The effectiveness of a fissure sealant after six years. *Pediatr Dent* 5:104-6, 1983.
3. Mertz-Fairhurst EJ, Fairhurst CW, Williams JE: A comparative clinical study of two pit and fissure sealants: six-year results in Augusta, Georgia. *JADA* 105:237-39, 1982.
4. Simonsen RJ: The clinical effectiveness of a colored pit and fissure sealant at 36 months. *JADA* 102:323-27, 1981.
5. Going RE, Loesche WJ, Grainger DA, Syed SA: The viability of microorganisms in carious lesions five years after covering with a fissure sealant. *JADA* 97:455-62, 1978.
6. Jensen OE, Handelman SL: Effect of an autopolymerizing sealant on viability of microflora in occlusal dental caries. *Scand J Dent Res* 88:382-88, 1980.
7. Jeronimus DJ, Till MJ, Sveen OB: Reduced viability of microorganisms under dental sealants. *J Dent Child* 42:275-80, 1975.
8. Theilade E, Fejerskov O, Migasena K, Prachyabrued W: Effect of fissure sealing on the microflora in occlusal fissures of human teeth. *Arch Oral Biol* 22:251-59, 1977.