Dental Sealants

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An Overview of Dental Sealants

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Introduction

Over the last few decades, several advancements have been made in caries prevention. Along with systemic and topical fluoride, the increased acceptance and use of pit and fissure sealants have without question had an impact on the prevention of caries. Fluorides have been found extremely effective in preventing caries on smooth surfaces of the teeth, but less effective on occlusal surfaces. Sealants protect the occlusal surfaces, inhibiting bacterial growth and providing a smooth surface that increases the probability that the surface will stay clean.

The concept of pit and fissure sealants was introduced when Dr. Michael Buonocore and colleagues at Eastman Dental Center in Rochester, New York, demonstrated the ability to acid etch a tooth surface and achieve a mechanical bond with certain dental materials. Until this development, all restorations required chemical retention. The first adaptation of the etching technique that included pits and fissures was reported in 1967.[1] Since then, researchers and clinicians have been working to improve the application technique and materials used to ensure long-term retention of sealants.

Evolution of Sealant Material

The ultimate goal of sealants is penetrating into the pit and fis-

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sures of the tooth and sealing them from bacteria. The ideal sealant material would have prolonged retention properties, low solubility in the oral environment, be biocompatible with the oral tissues, and be simple to apply.[2]

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Various materials have been suggested for use since 1967, but the most commonly used material is resin. Sealants in use now are second- and third-generation products with higher retention rates than the first-generation materials.[3] Types of sealant material currently available include filled, unfilled, and fluoride-releasing filled cyanocrylates; polyurethane resin; and bisphenol-A-glycidyl (bis-GMA) resins. Extensive research has compared the resins, but no single material has been found superior to the others.[4] Resins can be clear, tinted, or opaque; and once again, there is no difference in effectiveness; however, tinted and opaque shades allow for easier evaluation at both the initial and follow-up appointments.

Filler material, usually consisting of quartz and silica particles, is added to the resin to increase both bond strength and resistance to abrasion and wear. Clinicians often notice a slight increase in viscosity with filled resins as compared to unfilled resins. Filled resins are opaque, and are available in tooth-colored or white shades. Unfilled resins are a colorless or tinted transparent material.

Fluoride-releasing resins were developed to increase caries resistance. They are thought to remineralize incipient caries, but this has yet to be proven clinically. No difference in retention has been found between sealants containing fluoride and those that do not contain fluoride after one year.[5]

Sealant material also is categorized by its method of polymerization. There are currently two methods of polymerization for resins: 1) self-cured or autopolymerized (second-generation) and 2) light-cured or photopolymerized (third-generation). Numerous studies have compared bond strengths and retention rates of the two and found them similar.[6,7]

Self-cured or autopolymerized sealant is supplied in two parts that have to be mixed to activate polymerization. The working time can vary from 60 to 90 seconds; the warmer the environment, the quicker the material hardens. It is important to remember that the polymerization starts as the material is mixed, and that this limits the working time.

Light-cured or photopolymerized sealant material hardens when it is exposed to a curing light. The most obvious advantage to this system is the increased working time. A new photopolymerized sealant material, recently introduced, starts out pink in color and changes to white or tooth colored when polymerized (see Figures 1 and 2). This innovation may prevent retention failures due to incomplete polymerization.

Over the last few years, there has been an interest in using glass ionomer cements (GIC) for sealants, but research does not substantiate their effectiveness. One four-year study found that nearly all GIC sealants were lost, while resin-based sealants had a 61% retention rate.[8]

Recently, researchers and clinicians investigated the use of dentin bonding agents to enhance retention of sealants.

Figure 1.

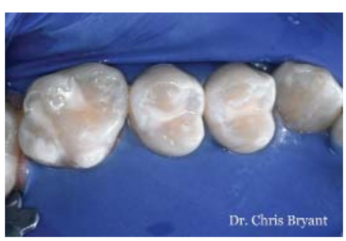

Figure 2.

Hotta et al. found that dentin bonding agents penetrate the etched surface more effectively than sealant material does.[9] Boksman et al. compared sealants placed with and without dentin bonding agents over a two-year period.[10] They concluded that bonding agents do not enhance the retention of sealants. Research is ongoing in determining the effectiveness of dentin bonding agents in the application of sealant retention rates.

Effectiveness and Retention of Sealants

Sealants are both cost effective and underutilized in prevention of occlusal caries. The long-term efficacy of sealants is well documented. In a 15-year study by Simonsen, 74% of permanent first molars that received sealants remained caries free.[11] Ripa published a review of the literature on sealant retention and found an average of 80% retention at one year, 71% for two years, 58% for three years, and 43% for four years.[12]

Sealants are lost most frequently from the lingual surfaces of maxillary molars and the buccal surfaces of mandibular molars.[12] This can be attributed to the shallower pits, which increase the difficulty of complete etching and retention.

Most clinicians find that retention rates are less for primary teeth; up to 50% less according to Lein.[13] The theory behind this reduction in retention is the direction of the enamel rods in primary teeth. The ends of enamel rods in permanent teeth form an angle perpendicular to the outer enamel surface, whereas the enamel rods in primary teeth often form an angle that does not allow for optimum retention.[13]

Initial retention failure of sealants is historically attributed to technique errors, the most common of which is moisture contamination.[14,15] Other technique errors that can affect retention are inadequate etching, incorporation of air bubbles into the sealant material (which weakens the material), and incomplete removal of debris from the pits and fissures prior to etching.

Sealant retention depends not only on proper application, but also on the eruption status of the tooth.[16,17] When a tooth is not completely erupted, the retention rate is lower—possibly due to difficulties maintaining a dry tooth surface during application. Without a doubt, the retention rate is lowered when an operculum is present over the distal marginal ridge of a molar. One study found a replacement rate of 54% on molars when an operculum was present, although no replacement was necessary on molars sealed later in the eruption process.[18]

Undoubtedly, sealants are susceptible to occlusal wear. This is a problem only if the seal at the margins of the sealant is not maintained. Again, this emphasizes the importance of continued evaluation of the sealant.

In the past, fluoride treatment prior to the sealant placement was contraindicated, because it was felt that the fluoride interfered with the bond between the sealant and the tooth surface. Recent research suggests that fluoride use prior to sealant placement may not adversely affect the bonding strength of enamel and sealants.[19-22] Further research is needed to validate these findings.

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Utilization Patterns of Sealant

Need versus Actual Practice

There is a large discrepancy between the recommendation and actual usage of sealants. Research shows that only 23% of children in second and third grades, and 20% of eighth- and ninth-graders, have their first molars sealed.[23]

The most recent national caries survey, the Third National Health and Nutritional Examination Survey (NHANES III), conducted between 1988 and 1991, addressed the prevalence of caries in primary and permanent teeth. The findings indicated that only 50% of 5- to 9-year-old children have caries-free primary dentition. Furthermore, only 19% of 5- to 17-year-old children had received at least one sealant.[24]

In 1990, the U. S. Public Health Service released objectives of Healthy People 2000, a national health promotion and disease preventive initiative that identified the most significant preventable threats to health, including dental caries. Healthy People 2000 set the goal that 50% of 8- to 14-year-old children to have one or more permanent molars sealed by the year 2000.[25] This objective reinforced and elevated the importance of sealants in the prevention of caries. Unfortunately, the sealant placement goal was not met. Healthy People 2010 objectives include 50% of children age 8 to 14 having one or more permanent molars sealed by 2010.[26]

The need for caries reduction and the role that sealants can play is well established. However, there continues to be a gap between the need for sealants and their actual placement. The array of reasons for not utilizing sealants in individuals at high caries risk includes lack of retention, lack of effectiveness, and an unwillingness of patients to pay for placement of sealants.

Lack of retention and effectiveness, as previously discussed, are not valid concerns as long as the sealants are placed correctly, achieve an appropriate seal, and are monitored routinely. Patients should be educated on the importance of sealants and their cost effectiveness compared to invasive restorative therapies.

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Indications for Use

Traditionally, sealants are thought of as a preventive measure for children and teenagers when they are in their "cavity-prone years." But placement of sealants should not be restricted by the patient's age. Patients who have xerostomia, are undergoing orthodontic treatment, show evidence of incipient caries, or who are prone to caries should be evaluated as candidates for sealant placement. Therefore, treatment planning for sealants should include more than the assessment of the tooth surface; it should include the patient's caries risk factors, including xerostomia and the anatomy of the tooth/teeth being evaluated.

Research indicates that the first and second permanent molars are the most susceptible to pit and fissure decay.[27,28] Bacteria can accumulate in deep pits and fissures and break down the enamel surface. Primary molars also can benefit from the placement of sealants.

Contraindications for Sealants

Not all molars and premolars benefit from sealants. Posterior teeth that have shallow or well-coalesced pits and fissures and/or low caries risk are poor candidates for sealant placement. Sealants are contraindicated for teeth with proximal decay evident either through radiographs or clinical detection, or with obvious occlusal decay. They also are contraindicated for semierupted teeth, especially molars with an operculum present. Assessment for sealant placement should be done once the eruption is complete.

Another contraindication for sealant use is patient allergy to methacrylate. Methacrylate is contained in the sealant material, and the oral tissues may come in contact with it during sealant placement.

Technique for Application of Sealants

The technique for applying sealants has remained basically the same over the years. There are seven basic steps involved in sealant placement: 1) tooth preparation; 2) isolation; 3) drying the tooth; 4) etching of the tooth surface; 5) rinsing and drying of tooth; 6) placement and polymerization of sealant material; and 7) occlusal evaluation (Table I).

There are several ways to prepare a tooth for a sealant. Traditionally, the clinician polishes the surface with pumice or prophy paste. This step also can be accomplished by having the patient direct the bristles of a dry brush into occlusal pits and fissures. Another option is cleaning the surface with air polishers. The goal is removal of all deposits and debris from the pits and fissures. Often, an explorer is used to remove any debris that might be deep in the pit or fissure. The surface should be rinsed thoroughly for 20–30 seconds and reevaluated for residual debris or loosened pumice/prophy paste.

Next, the area needs to be isolated to provide a dry working field that will enhance retention and minimize the chance of material being swallowed. Isolation can be accomplished with cotton rolls, dry angles over the parotid duct, and/or a rubber dam. A rubber dam will help control saliva and tongue movement during the procedure, and is usually used when more than one tooth is sealed.

Once isolated, the tooth/teeth to be treated need(s) to be dried thoroughly with air. Any moisture on the surface during the placement of the sealant will interfere with the bonding of the material to the tooth and compromise retention.

Table I. Sealant placement guidelines

Step 1: Prepare the teeth
- Clean the pit and fissure surfaces
- Utilize a dry toothbrush, prophy cup with pumice or prophy paste, or air abrasion
- Use an explorer to remove any debris in the pit or fissure
- Rinse for 20–30 seconds
- Reevaluate surface for residual or loose debris

Step 2: Isolate the teeth
- Use cotton rolls, dry angles, and/or rubber dam

Step 3: Dry the surfaces
- Dry teeth with air for 20–30 seconds
- Check to make sure there is no moisture coming out of air syringe tip

Step 4: Etch the surfaces
- Apply etchant as directed by manufacturer
- Usually between 30–60 seconds
- If using a gel or semi-gel: apply gel and let stand for the allotted amount of time
- If using a liquid: continue to apply etchant throughout the etchant time

Step 5: Rinsing and drying the teeth
- Rinse surfaces for 60 seconds
- Check for effectiveness of etchant by drying with air; surface should appear “chalky white”
- If not, repeat etching procedure
- Placement of new cotton rolls and/or dry angles
- Dry teeth with air for 20–30 seconds

Step 6: Application of sealant material
- Self-curing: mix equal parts of the two components
  - Will polymerize in 60–90 seconds
- Light-curing: apply with syringe provided by manufacturer
  - Apply curing light to material
  - Will polymerize in 20–30 seconds
- Evaluate sealant for any voids, marginal discrepancies, or retention problems
  - If noted, return to step 2

Step 7: Occlusal evaluation
- Check occlusion with articulating paper
- Adjustments must be made with filled resins

Step 8: Setting re-evaluation sequence
- Educating patient of the importance in having the sealants evaluated on a six-month basis

The fourth step is acid etching of the tooth/teeth surface(s). Acid etching is performed to produce irregularities in the enamel surface, which allows the sealant material to flow into the microspores. In turn

Figure 3.

this will permit mechanical retention of the sealant material. Etchant is available in different concentrations and forms: liquid, gel, or semi-gel. Follow the manufacturer's directions for application and the length of time to etch each surface for optimal results. The acid etch should be rinsed from surfaces and the area thoroughly dried after completion of etching. The surface to be sealed should appear "chalky" white. If this is not the case, repeat the etching process.

Making certain that the tooth/teeth surfaces to be sealed are dry and isolated prior to placement of the sealant material is by far the most critical aspect of the placement process.Self-curing sealant should be mixed in a way to avoid incorporating air bubbles. Light-cured material can be applied with a brush, a sponge, or the disposable syringe provided by the manufacturer (see Figure 3). With either system, make sure that the pits and fissures are not overfilled. Self-curing material will be polymerized in 60–90 seconds. With photopolymerization materials, the curing light should be applied for 20–30 seconds, depending on the manufacturer's directions.

Once polymerization is complete, the sealants should be evaluated for surface voids. If voids are noted at this point, additional material can be added. In addition to checking for surface voids, evaluate the retention of the sealant. If retention is not successful, the process should be repeated with an emphasis on isolation and etching of the surface(s).

Once the sealant has been evaluated for proper placement, the occlusion should be checked with articulating paper. If the sealant material is an unfilled resin, it will wear down to the appropriate height naturally; therefore, no occlusal adjustments are needed. However, filled resin will require occlusal adjustment if a high spot is noticed during the occlusal evaluation.

The last step of sealant application involves educating the patient or primary caregiver about the importance of periodic reevaluation of the sealants. This step is crucial to the success and longevity of sealants. During the reevaluation appointment, the clinician should perform both visual and tactile examinations, looking for lost material, voids in the surface or margins of the material, and/or possible caries development.

Conclusion

Underutilization of sealants as a method of disease prevention continues to be a public health issue. There also is uncertainty about placing a sealant over incipient decay. Research supports the theory that placing a sealant over incipient decay reduces the number of microorganisms present and has no deleterious effect.[29–31]

Unfortunately, some clinicians perceive a high failure rate for sealants and therefore do not recommend them (although this does not seem to be the case with registered dental hygienists). A recent study indicated that 94.9% of registered dental hygienists surveyed felt sealants were very effective and/or effective while only 3.3 felt they were

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somewhat effective, 0.6 felt they were not effective, and 1.2 didn't know if they were effective or not.[32] It appears that dental hygienists' sealant utilization and knowledge are affected by emphasis placed on the procedure in dental hygiene school, demographics of the dental hygienist's practice setting, and the availability of third-party reimbursements.[33]

Without question, when applied correctly, sealants are an exceptional preventive service for patients at high risk for caries. As preventive specialists, dental hygienists need to use existing research and literature to close the gap between the recommendation of sealants and their actual use as a means to reduce caries.

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