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Research Paper

History and Selection of Pit and Fissure Sealents – A Review.

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ABSTRACT: *Two strategies for fluoroprophylaxis have been proposed: the first is the systemic fluoroprophylaxis which is especially effective in averting interproximal caries, however it doesn't frame a satisfactory defensive obstruction on the occlusal surfaces; the other is the topical use of a fluoride gel to the tooth surface, in spite of the fact that this second strategy does not fundamentally diminish the frequency of caries. The viability of the fixing methods relies on upon the right application procedure. Watching an agent convention will guarantee a more extended enduring maintenance of the sealant on the occlusal surface and in this manner drags out the security against caries. This review gives the in and out details about pit and fissure sealents.*

Keywords: *Pit and fissure Sealents, History, Application.*

I. HISTORY

Historically several agents have been tried to protect deep pits and fissures on occlusal surfaces. In 1895, Wilson reported the placement of dental cement in pits and fissures to prevent caries.[1-4] In 1929, Bodecker4 suggested that deep fissures could be broadened with a large round bur to make the occlusal areas more self-cleansing, a procedure that is called enameloplasty.[5] Two major disadvantages, however, accompany enameloplasty. First, it requires a dentist, which immediately limits its use. Second, in modifying a deep fissure by this method, it is often necessary to remove more sound tooth structure than would be required to insert a small restoration. In 1923 and again in 1936, Hyatt [6] advocated the early insertion of small restorations in deep pits and fissures before carious lesions had the opportunity to develop. He termed this procedure prophylactic odontotomy. Again, this operation is more of a treatment procedure than a preventive approach, because it requires a dentist for the cutting of tooth structure. Several methods have been unsuccessfully used in an attempt either to seal or to make the fissures more resistant to caries.

These attempts have included the use of topically applied zinc chloride and potassium ferrocyanide[7] and the use of ammoniacal silver nitrate;[8] they have also included the use of copper amalgam packed into the fissures.[9] Fluorides that protect the smooth surfaces of the teeth are less effective in protecting the occlusal surfaces.[10] Following the use of fluorides, there is a large reduction of incidence in smooth-surface caries but a smaller reduction in occlusal pit-and-fissure caries. This results in an increased proportion in the ratio of occlusal to interproximal lesions, even though the total number may be less. A final course of action to deal with pit-and-fissure caries is one that is often used: do nothing; wait and watch. This option avoids the need to cut good tooth structure until a definite carious lesion is identified. It also results in many teeth being lost when individuals do not return for periodic exams. This approach, although frequently used is a violation of the ethical principle of beneficence and patient autonomy. In the late 1960s and early 1970s, another option became available the use of pit-and-fissure sealants.[11] With this option, a liquid resin is flowed over the occlusal surface of the tooth where it penetrates the deep fissures to fill areas that cannot be cleaned with the toothbrush.[12] The hardened sealant presents a barrier between the tooth and the hostile oral environment. Concurrently, there is a significant reduction of Streptococcus mutans on the treated tooth surface.[13] Pits and fissures serve as reservoirs for mutans streptococci, sealing the niche thereby reduces the oral count.

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II. CRITERIA FOR SELECTING TEETH FOR SEALANT PLACEMENT

Following are the criteria for selecting teeth for sealing. Because no harm can occur from sealing, when in doubt, seal and monitor.A deep occlusal fissure, fossa, or incisal lingual pit is present.A sealant is contraindicated if: Patient behavior does not permit use of adequate dry-field techniques throughout the procedure. An open carious lesion exists. Caries exist on other surfaces of the same tooth in which restoring will disrupt an intact sealant. A large occlusal restoration is already present. A sealant is probably indicated if: The fossa selected for sealant placement is well isolated from another fossa with a restoration. The area selected is confined to a fully erupted fossa, even though the distal fossa is impossible to seal due to inadequate eruption. An intact occlusal surface is present where the contralateral tooth surface is carious or restored; this is because teeth on opposite sides of the mouth are usually equally prone to caries. An incipient lesion exists in the pit-and-fissure. Sealant material can be flowed over a conservative class I composite or amalgam to improve the marginal integrity, and into the remaining pits and fissures to achieve a de facto extension for prevention.[13]

III. OTHER CONSIDERATIONS IN TOOTH SELECTION

All teeth meeting the previous criteria should be sealed and resealed as needed. Where the cost-benefit is critical and priorities must be established, such as occurs in many public health programs, ages 3 and 4 years are the most important times for sealing the eligible deciduous teeth; ages 6 to 7 years for the first permanent molars;[14] and ages 11 to 13 years for the second permanent molars and premolars.[15] Currently, 77% of the children 12-to-17-years-old in the United States have dental caries in their permanent teeth.[1] Many school days would be saved, and better dental health would be achieved in School Dental Health Clinic programs by combining sealant placement and regular fluoride exposure.[16] The disease susceptibility of the tooth should be considered when selecting teeth for sealants, not the age of the individual. Sealants appear to be equally retained on occlusal surfaces in primary, as well as permanent teeth.[3] Sealants should be placed on the teeth of adults if there is evidence of existing or impending caries susceptibility, as would occur following excessive intake of sugar or as a result of a drug- or radiation-induced xerostomia. They should also be used in areas where fluoride levels in community water is optimized, as well as in non-fluoridated areas.[17] The following are two good illustrations of this philosophy. After a 3-year study, Ripa and colleagues[18] concluded that the time the teeth had been in the mouth (some for 7 to 10 years) had no effect on the vulnerability of occlusal surfaces to caries attack. Also, the incidence of occlusal caries in young Navy[19] and Air Force[20] recruits (who are usually in their late teens or early 20s) is relatively high.

IV. BACKGROUND OF SEALANTS

Buonocore first described the fundamental principles of placing sealants in the late 1960s.[10,21] He describes a method to bond poly-methylmethacrylate (PMMA) to human enamel conditioned with phosphoric acid. Practical use of this concept however, was not realized until the development of bisphenol A-glycidyl methacrylate (Bis-GMA), urethane dimethacrylates (UDMA) and trithylene glycol dimethacrylates (TEGDMA) resins that possess better physical properties than PMMA. The first successful use of resin sealants was reported by Buonocore in the 1960s.[22] Bisphenol A-Glycidyl Methylacrylate Sealants. Bisphenol A-glycidyl methylacrylate (Bis-GMA) is now the sealant of choice. It is a mixture of Bis-GMA and methyl methacrylate.[23] Products currently accepted by the American Dental Association (ADA) include:[24]. Baritone L3, Type II Confi-Dental Products Co. Alpha-Dent Chemical Cure Pit and Fissure Sealant Dental Technologies, Inc. Alpha-Dent Light Cure Pit and Fissure Sealant Dental Technologies, Inc. Prisma-Shield Compules Tips VLC Tinted Pit & Fissure Sealant Dentsply L.D. Caulk Division. Prisma-Shield VLC Filled Pit & Fissure Sealant Dentsply L.D. Caulk Division. Helioseal F, Type II Ivoclar-Vivadent, Inc. Helioseal, Type II Ivoclar-Vivadent, Inc. Seal-Rite Low Viscosity, Type II Pulpdent Corp. Seal-Rite, Type II Pulpdent Corp.

The ADA National Standard sets aside specific criteria of pit-and-fissure sealants stating; Specification No. 39 established the following requirements: That the working time for type I sealants is not less than 45 seconds; That the setting time is within 30 seconds of the manufacturer's instruction and does not exceed three minutes; That the curing time for type II sealants is not more the 60 seconds; That the depth of cure for type II sealant is not less than 0.75 millimeter; That the uncured film thickness is not more than 0.1 millimeter; That sealants meet the bicompatibility requirements of American Nation a Standard/American Dental Association Document No. 41 for Recommended Standard Practices for Biological Evaluation of Dental Materials.[25] Sealant products accepted by the American Dental Association carried the statement: "[Product name] has been shown to be acceptable as an agent for sealing off an anatomically deficient region of the tooth to supplement the regular professional care in a program of preventive dentistry."[26] Nuva-Seal was the first successful commercial sealant to be placed on the market, in 1972. The first sealant clinical trials used cyanoacrylate-based materials. Dimethacrylate-based products replaced these. The primary difference between sealants is their method of polymerization. First-generation sealants were initiated by ultraviolet light, second-generation sealants are

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autopolymerized, and third-generation sealants use visible light. Some sealants contain fillers, which makes it desirable to classify the commercial products into filled and unfilled sealants. The filled sealants contain microscopic glass beads, quartz particles, and other fillers used in composite resins. The fillers are coated with products such as silane, to facilitate their combination with the Bis-GMA resin. The fillers make the sealant more resistant to abrasion and wear. Because they are more resistant to abrasion the occlusion should be checked and the sealant height may need to be adjusted after placement. In contrast, unfilled sealants wear quicker but usually do not need occlusal adjustment.

V. POLYMERIZATION OF THE SEALANTS

The liquid resin is called the monomer. When the catalyst acts on the monomer, repeating chemical bonds begin to form, increasing in number and complexity as the hardening process (polymerization) proceeds. Finally, the resultant hard product is known as a polymer. Two methods have been employed to catalyze polymerization: (1) light curing by use of a visible blue light (synonyms: photocure, photoactivation, light activation) and (2) self-curing, in which a monomer and a catalyst are mixed together (synonyms: cold cure, autopolymerization, and chemical activation). The two original Caulk products, Nuva-Seal and Nuva-Cote, were the only sealants in the United States requiring ultraviolet light for activation. Both have been replaced by other light-cured sealants that require visible blue light. In the manufacture of these latter products, a catalyst, such as camphoroquinone, which is sensitive to visible blue-light frequencies, is placed in the monomer at the time of manufacture. Later, when the monomer is exposed to the visible blue light, polymerization is initiated. With the autopolymerizing sealants, the catalyst is incorporated with the monomer; in addition, another bottle contains an initiator usually benzoyl peroxide. When the monomer and the initiator are mixed, polymerization begins

VI. OCCLUSAL AND INTERPROXIMAL DISCREPANCIES

At times an excess of sealant may be inadvertently flowed into a fossa or into the adjoining interproximal spaces. To remedy the first problem, the occlusion should be checked visually or, if indicated, with articulating paper. Usually any minor discrepancies in occlusion are rapidly removed by normal chewing action. If the premature contact of the occlusal contact is unacceptable, a large, no. 8. round cutting bur may be used to rapidly create a broad resin fossa. The integrity of the interproximal spaces can be checked with the use of dental floss. If any sealant is present, the use of scalers may be required to accomplish removal. These corrective actions are rarely needed once proficiency of placement is attained.

VII. EVALUATING RETENTION OF SEALANTS

The finished sealant should be checked for retention without using undue force. In the event that the sealant does not adhere, the placement procedures should be repeated, with only about 15 seconds of etching needed to remove the residual saliva before again flushing, drying, and applying the sealant. If two attempts are unsuccessful, the sealant application should be postponed until remineralization occurs. Resin sealants are retained better on recently erupted teeth than in teeth with a more mature surface; they are retained better on first molars than on second molars. They are better retained on mandibular than on maxillary teeth. This latter finding is possibly caused by the lower teeth being more accessible, direct sight is also possible; also, gravity aids the flow of the sealant into the fissures.[27] Teeth that have been sealed and then have lost the sealant have had fewer lesions than control teeth. This is possibly due to the presence of tags that are retained in the enamel after the bulk of the sealant has been sheared from the tooth surface. When the resin sealant flows over the prepared surface, it penetrates the finger-like depressions created by the etching solution. These projections of resin into the etched areas are called tags. The tags are essential for retention. Scanning electron microscopic studies of sealants that have not been retained have demonstrated large areas devoid of tags or incomplete tags, usually caused by saliva contamination. If a sealant is forcefully separated from the tooth by masticatory pressures, many of these tags are retained in the etched depressions. The number of retained sealants decreases at a curvolinear rate.[27] Over the first 3 months, the rapid loss of sealants is probably caused by faulty technique in placement. The fallout rate then begins to plateau, with the ensuing sealant losses probably being due to abnormal masticatory stresses. After a year or so, the sealants become very difficult to see or to discern tactilely, especially if they are abraded to the point that they fill only the fissures.

In research studies this lack of visibility often leads to underestimating the effectiveness of the sealants that remain but cannot be identified. Because the most rapid falloff of sealants occurs in the early stages, an initial 3-month recall following placement should be routine for determining if sealants have been lost. If so, the teeth should be resealed. Teeth successfully sealed for 6 to 7 years are likely to remain sealed.[28] In a review of the literature, longest-term study reported that at the follow-up examination of the first molars, 20-years after sealant had been applied, 65% showed complete retention and 27% partial retention without caries. At a 15-year follow-up of the same sealants the second molars demonstrated the corresponding figures 65% and 30%, respectively. This study showed that pit-and-fissure sealants applied during childhood have a long-lasting, caries preventive effect. Mertz-Fairhurst[28] cited studies in which 90 to 100% of the original sealants were retained over a 1-year period. One 10-year study using 3M Concise Sealant had a 57% complete retention and a 21% partial retention of sealant, all with no caries. Another study, using Delton, registered 68% retention after 6 years.108. These are studies in which the sealant was placed and then observed at periodic intervals; there was no resealing when a sealant was lost. Where resealing is accomplished as needed at recall appointments, a higher and more continuous level of protection is achieved. More recent studies report 82% of the sealants placed are retained for 5 years.[29]

VIII. THE HIGH-INTENSITY LIGHT SOURCE

The light-emitting device consists of a high-intensity white light, a blue filter to produce the desired blue color, usually between 400 to 500 nm, and a light-conducting rod. Some other systems consist of a blue light produced by light-emitting diodes (LED). Most have timers for automatically switching off the lights after a predetermined time interval. In use, the end of the rod is held only a few millimeters above the sealant during the first 10 seconds, after which it can be rested on the hardened surface of the partially polymerized sealant. The time required for polymerization is set by the manufacturer and is usually around 20 to 30 seconds. The depth of cure is influenced by the intensity of light, which can differ greatly with different products and length of exposure. Often it is desirable to set the automatic light timer for longer than the manufacturer's instructions.[30] Even after cessation of light exposure, a final, slow polymerization can continue over a 24-hour period.[31] It is not known whether long-term exposure to the intense light can damage the eye. Staring at the lighted operating field is uncomfortable and does produce afterimages. This problem is circumvented by the use of a round, 4-inch dark-yellow disk, which fits over the light housing. The disk filters out the intense blue light in the 400- to 500-nanometers range as well as being sufficiently dark to subdue other light frequencies.

IX. INCREASING THE SURFACE AREA

Sealants do not bond directly to the teeth. Instead, they are retained mainly by adhesive forces.[32] To increase the surface area, which in turn increases the adhesive potential, tooth conditioners (also called etchants), which are composed of a 30 to 50% concentration of phosphoric acid, are placed on the occlusal surface prior to the placement of the sealant.[33] The etchant may be either in liquid or gel form. The former is easier to apply and easier to remove. Both are equal in abetting retention.[34,35] If any etched areas on the tooth surface are not covered by the sealant or if the sealant is not retained, the normal appearance of the enamel returns to the tooth within 1 hour to a few weeks due to a remineralization from constituents in the saliva.[36] The etchant should be carefully applied to avoid contact with the soft tissues. If not confined to the occlusal surface, the acid may produce a mild inflammatory response. It also produces a sharp acid taste that is often objectionable.

X. PIT-AND-FISSURE DEPTH

Deep, irregular pits and fissures offer a much more favorable surface contour for sealant retention compared with broad, shallow fossae. The deeper fissures protect the resin sealant from the shear forces occurring as a result of masticatory movements. Of parallel importance is the possibility of caries development increasing as the fissure depth and slope of the inclined planes increases.[37,38] Thus, as the potential for caries increases, so does the potential for sealant retention.

XI. SURFACE CLEANLINESS

The need and method for cleaning the tooth surface prior to sealant placement are controversial. Usually the acid etching alone is sufficient for surface cleaning. This is attested to by the fact that two of the most cited and most effective sealant longevity studies by Simonsen[39] and Mertz-Fairhurst[40] were accomplished without use of a prior prophylaxis. Recently, however, it was shown that cleaning teeth with the newer prophylaxis pastes with or without fluoride (NuPro, Topex) did not affect the bond strength of sealants[,41] composites,[42] or orthodontic brackets. Other methods used to clean the tooth surface prior to placing the sealant included, air-polishing, hydrogen peroxide, and enameloplasty.[42-44] The use of an air-polisher has proven to thoroughly clean and removes residual debris from pits and fissures.[44-47] Hydrogen peroxide has the disadvantage that it produces a precipitate on the enamel surface.[47] Enameloplasty, achieved by bur or air abrasion has proven effective. Yet, no significant differences were observed in comparison with either etching or bur preparation of the fissures on the penetration to the base of the sealant. However, the use of enameloplasty, even if equal or slightly superior would have very serious ramifications. The laws of most states require a dentist to use air abrasion and/or to cut a tooth, a requirement that would severely curtail hygienists and assistants participation in office and school preventive dentistry programs.[69] Whatever the cleaning preferences either by acid etching or other methods all heavy stains, deposits, debris, and plaque should be removed from the occlusal surface before applying the sealant.

XII. DRYNESS

The teeth must be dry at the time of sealant placement because sealants are hydrophobic. The presence of saliva on the tooth is even more detrimental than water because its organic components interpose a barrier between the tooth and the sealant. Whenever the teeth are dried with an air syringe, the air stream should be checked to ensure that it is not moisture-laden. Otherwise, sufficient moisture sprayed on the tooth will prevent adhesion of the sealant to the enamel. A check for moisture can be accomplished by directing the air stream onto a cool mouth mirror; any fogging indicates the presence of moisture. Possibly the omission of this simple step accounts for the inter-operator variability in the retention of fissure sealants. A dry field can be maintained in several ways, including use of a rubber dam, employment of cotton rolls, and the placement of bibulous pads over the opening of the parotid duct. The rubber dam provides an ideal way to maintain dryness for an extended time. Because a rubber dam is usually employed in accomplishing quadrant dentistry, sealant placement for the quadrant should also be accomplished during the operation. Under most operating conditions, however, it is not feasible to apply the dam to the different quadrants of the mouth; instead it is necessary to employ cotton rolls, combined with the use of an effective high-volume, low-vacuum aspirator. Under such routine operating conditions, cotton rolls, with and without the use of bibulous pads, can usually be employed as effectively as the dam for the relatively short time needed for the procedure.

The two most successful sealant studies have used cotton rolls for isolation.[39,40] In one study in which retention was tested using a rubber dam versus cotton rolls, the sealant retention was approximately equal.[49] Others have shown excellent sealant retention after 3 years[50] and after 10 to 20 years.[60,] In programs with high patient volume where cotton rolls are used, it is best to have two individuals involved the operator, whose main task is to prepare the tooth and to apply the sealant, and the assistant, whose task is to maintain dryness. An operator working alone, however, can maintain a maximum dry field for the time needed to place the sealants, although it is not recommended, particularly for young children or those that are difficult to manage. For the maxilla, there should be little problem with the placement of cotton rolls in the buccal vestibule and, if desirable, the placement of a bibulous pad over the parotid duct. For the mandible, a 5-inch segment of a 6-inch cotton roll should be looped around the last molar and then held in place by the patient using the index and third fingers of the opposite hand from the side being worked on. With aid from the patient and with appropriate aspiration techniques, the cotton rolls can usually be kept dry throughout the entire procedure. Cotton roll holders may be used, but they can be cumbersome when using the aspirator or when attempting to manipulate or remove a roll. If a cotton roll does become slightly moist, many times another short cotton roll can be placed on top of the moist segment and held in place for the duration of the procedure. In the event that it becomes necessary to replace a wet cotton roll, it is essential that no saliva contacts the etched tooth surface; if there is any doubt, it is necessary to repeat all procedures up to the time the dry field was compromised.[51] This includes a 15-second etch to remove any residual saliva, in lieu of the original 1-minute etch. Another promising dry-field isolating device that can be used for single operator use, especially when used with cotton rolls, is by using ejector moisture-control systems. In one study comparing the Vac-Ejector versus the cotton roll for maintaining dryness, the two were found to be equally effective.[52]

XIII. MANPOWER

The cost of sealant placement increases directly with the level of professional education of the operator. Dentists, hygienists, assistants, and other auxiliaries can be trained to place sealants.[53-55] In view of the cost-effectiveness, dental auxiliaries should be considered as the logical individuals to place sealants. This is important if manpower is to be increased. Often auxiliaries who have received sealant instruction, either through continuing-education courses or as part of a curriculum, are stymied either because of state laws interdicting their placing sealants or by the nature and philosophy of the practice of the employing dentist.[56] Only fourteen states allow hygienists to practice under less restrictive or unsupervised practice models in which they can initiate treatment based on assessment of patient, treat the patient, and maintain a provider-patient relationship without the participation of the patients' dentist of record. For example, Maine and New Hampshire have a separate supervision for settings outside of the dental office public-health supervision, which is less restrictive than general supervision. New Mexico allows for a collaborative-practice agreement between dentists and hygienists in outside settings. Yet, in states such as Georgia and Illinois, hygienists are required to practice under direct supervision. This means the dentist must be present in the office while the care is being provided.[57] In a Swedish study, 77 dental assistants working in 12 dental clinics sealed 3,218 first and second molars with a 5-year retention rate of between 74 and 94%.[58] Because many dentists consider the placement of sealants to be a relatively simple procedure, few are returning for continuing-education programs to learn the exacting and precise process necessary to ensure maximum sealant retention. Even when the dental professionals desire to participate in such continuing education, a survey found relatively few courses available.[59]

XIV. ECONOMICS

Bear in mind that not every tooth receiving a sealant would necessarily become carious; hence the cost of preventing a single carious lesion is greater than the cost of a single sealant application. For instance, Leverett and colleagues calculated that five sealants would need to be placed on sound teeth to prevent one lesion over a 5-year period,[60] and Rock and Anderson estimated one tooth for every three sealant applications are prevented from becoming carious.[61] Sealants would be most cost-effective if they could be placed in only those pits and fissures that are destined to become carious. Unfortunately, we do not have a caries predictor test of such exactitude, but, the use of vision plus an economic, portable electronic device that objectively measures conductance (or resistance) would greatly aid in evaluating occlusal risk.[62]Without such a device, it is necessary to rely on professional judgment, based on the severity of the caries activity indicators: number of "sticky" fissures, level of plaque index, number of incipient and overt lesions, and microbiologic test indications. In an office setting, it is estimated that it costs 1.6 times more to treat a tooth than to seal. The Task Force on Community Preventive Services, an independent, non-federal group formed to evaluated oral-health interventions, was charged with determining interventions that promote and improve oral health. The Task Force examined six public-health programs cost of placing pit-and-fissure sealants revealing a mean cost of $39.10 per person.[63] However, even these numbers are misleading. For instance, what is the value of an intact tooth to its owner? How much does it cost for a dentist and assistant to restore a tooth, compared to the cost of sealing a tooth? Later in life, what is the cost of bridges and dentures that had their genesis when children were at high risk with little access to dental care?

XV. CONCLUSION

The surfaces that are to receive the sealant must be completely isolated from the saliva during the entire procedure, and etching, flushing, and drying procedures must be timed to ensure adequate preparation of the surface for the sealant. Sealants are comparable to amalgam restorations for longevity and do not require the cutting of tooth structure. Sealants do not cost as much to place as amalgams. Despite their advantages, the use of sealants has not been embraced by all dentists, even though endorsed by the ADA and the U.S. Public Health Service. Even when small overt pit-and-fissure lesions exist, they can be dealt with conservatively by use of preventive dentistry restorations. What now appears to be required is that the dental schools teach sealants as an effective intervention, that the dental professional use them, that the hygienists and the auxiliary personnel be permitted to apply them, and the public demand them.

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