Pit and Fissure Sealants: An Unused Caries Prevention Tool

J Avinash, CM Marya, S Dhingra, P Gupta, S Kataria, Meenu, Hind Pal Bhatia

ABSTRACT

Pit and fissure sealants along with fluoridation and good oral hygiene is an important tool for the prevention of dental caries in children and adolescents.

RECOMMENDATIONS: The following recommendations are based on the evidence gathered : 1. Sealants should be placed on all permanent teeth without cavitation (i.e., teeth that are free of caries, teeth that have deep pit and fissure morphology, teeth with "sticky" fissures or teeth with stained grooves) as soon after eruption as isolation can be achieved. 2. Sealants should not be placed on partially erupted teeth or teeth with cavitation or caries of the dentin. 3. Sealants should be placed on the primary molars of children who are susceptible to caries (i.e., those with a history of caries). 4. Sealants should be placed on first and second molars within 4 years after eruption. 5. Resin-based sealants should be preferred, until such time as glass ionomer cements with better retention capacity are developed. 6. Sealants should be placed as part of an overall prevention strategy based on assessment of caries risk. Sealing is a recommended procedure to prevent caries of the occlusal surfaces of permanent molars. Though the effectiveness of sealants is obvious at high caries risk groups there is still some degree of latitudein operators preference for sealant placementand material selection.

Key words: Pit and fissure sealants, Caries prevention tool,

Contact Author

Dr. CM Marya

E-mail : maryacm@yahoo.co.uk

J Oral Health Comm Dent 2010;**4**(1):1-6

Increasingly, the attention of the dental profession has been directed towards prevention of dental caries in pits and fissures. Pit and fissure sealants have been recommended for caries prevention, along with good oral hygiene, optimal fluoridation, and healthy dietary habits. To be effective in the prevention of pit and fissure caries, a sealant must truly 'seal', i.e. it must completely keep out fermentable food substrates.

Historical Perspective

Attempts to prevent caries attack have been reported from the beginning of this century, i.e. application of silver nitrate by **Miller** in 1905.

During the 1920's, two different clinical techniques were introduced in an attempt to reduce the extent and severity of pit and fissure caries in occlusal and smooth surfaces. In 1924, Thaddeus Hyatt(1) advocated prophylactic restorations. This procedure consisted of preparing a conservative class I cavity that included all pits and fissures at risk for caries development and then placing an amalgam restoration.

A more conservative approach to prevention of pit and fissure caries was presented by Bodecker(2) in 1929.Initially,he advocated cleaning the fissure with an explorer and flowing a thin mix of oxyphosphate cement into the fissure-essentially an attempt to seal the fissure. Later, he introduced an alternate method for caries prevention, the prophylactic odontotomy, which involved mechanical eradication of fissures in order to transform deep, retentive fissures into cleansable ones. These two techniques, prophylactic restoration and prophylactic odontotomy, were employed until the use of sealants became prevalent.

The development of pit and fissure sealants was based on the discovery that etching enamel with phosphoric acid increased the retention of resin restorative materials and improved marginal integrity considerably. The initial studies evaluating the effects of acid-etching on enamel were performed by Buonocore(3) in 1955.The first sealant material that utilized the acid-etched technique was introduced in the mid-1960's and was a cyanoacrylate substance. Cyanoacrylates were not suitable as sealant material owing to bacterial degradation of the material in the oral cavity over time. By the late 1960's,a number of different resin materials had been tested, and a viscous resin was found to be resistant to degradation and produced a tenacious bond with the etched enamel. This resin was formed by reacting bisphenol A with glycidyl methacrylate, and this class of dimethacrylate resins are known as BIS-GMA (Bowen, 1982)(4).

BIS-GMA is a relatively large epoxy resin-like hybrid monomer in which epoxy groups are replaced by methacrylate groups. BIS-GMA incorporates the rapid polymerization characteristic of methylmethacrylate with the minimal polymerization shrinkage property of epoxy resins.

In addition to BIS-GMA sealants, Glass ionomer materials have also been used as pit and fissure sealants. Glass ionomers bond to both enamel and dentin by physicochemical mechanisms following polyacrylic acid conditioning. The primary advantage of glass ionomers over conventional BIS-GMA sealants is the ability of glass ionomers to release fluoride. Incorporation of the released fluoride into the adjacent enamel and dentin may enhance caries resistance, remineralize enamel caries and affected dentin, and alter the bacterial composition and metabolic byproducts of plaque (Hicks et al., 1986).

The effect of fissure morphology and eruption time on penetration and adaptation of pit and fissure sealants (Grewal N, Chopra R)(6)

- Significant difference in penetration was due to the different shapes of the fissures and was not affected by the time of eruption
  - The depth of penetration was comparable in V-shaped and U-shaped fissures; it was found to be better than the penetration in other shapes
  - For I and IK-shaped fissures, the level of penetration was again found to be similar and was poorer than in the other shapes
  - For Y-shaped fissures, the depth of penetration was less than that for U and V-types but more than that for I and IK-types

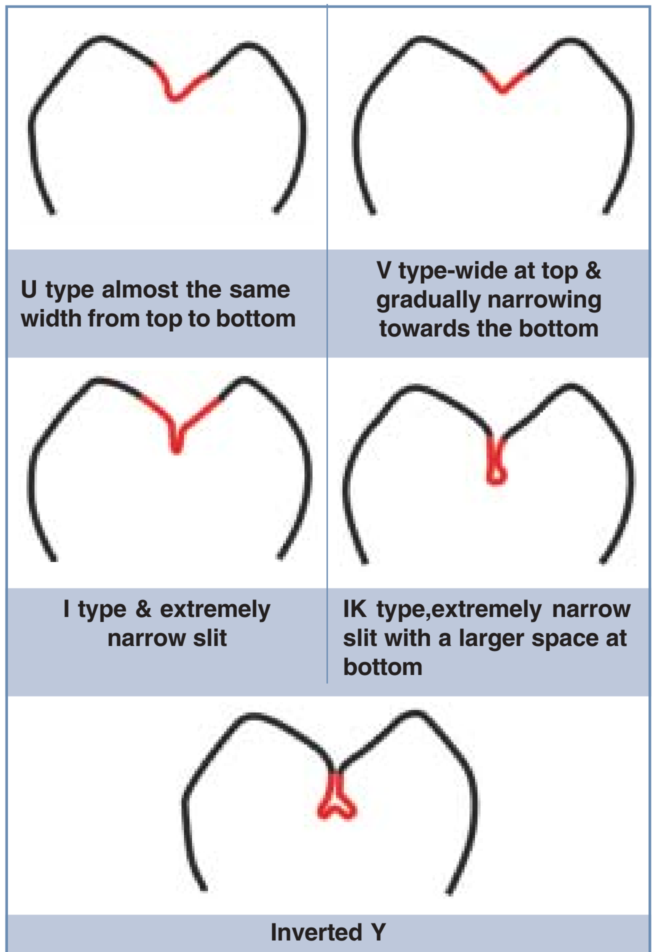

Fig. 1: Nagano(5) classified occlusal fissure into five types on the basis of fissure morphology :V,U,Y,I,IK types.

- Adhesion of the sealant to the lateral walls of fissure was independent of both the shapes and the eruption times of the teeth

When to seal

- Stained pits and fissures with minimum appearance of decalcification or opacification
- Deep, retentive pits and fissures, which may cause wedging or catching of an explorer
- Pit and fissure caries
- No radiographic or clinical evidence of interproximal caries in need of restoration on teeth to be sealed
- Use of other preventive treatment such as systemic or topical fluoride therapy, to inhibit interproximal caries formation
- Tooth considered for sealant application erupted less than 4 years ago
- Possibility of adequate isolation from salivary contamination

When not to seal

- Well-coalesced, self-cleansing pits and fissures
- Radiographic or clinical evidence of interproximal caries in need of restoration
- Presence of many interproximal lesions or restorations and no preventive treatment to inhibit interproximal caries formation
- Tooth partially erupted and no possibility of adequate isolation from salivary contamination
- Pit and fissure surface that has remained caries-free for 4 years or longer and has no clinical indications for sealant placement

Clinical technique for sealant restorations:

It includes:

- Cleaning the pit & fissure surface
- Isolation
- Etching the enamel surface
- Thoroughly rinse & dry the tooth
- Sealant application
- Polymerization
- Evaluation of the tooth

Cleaning the pit and fissure surfaces

Plaque and debris might interfere with the etching process or sealant penetration.

Historically, it has been advocated to clean the surfaces with a prophy cup or bristle brush and pumice. Use of prophy pastes, especially those with fluoride, have been discouraged because it was thought that the fluoride might make the enamel surface less reactive to the etchant and thereby reduce the bond strength.

Air polishing of the occlusal surface using Prophy-Jet or Cavi-Jet units has been the subject of several studies. (7-13)In vitro sealant studies with the Prophy-Jet have shown that fissures cleaned with a Prophy-Jet before acid etching have less residual debris,(7,8)greater sealant penetration(9) and a greater number of resin tags for micromechanical retention(10) and demonstrate higher tensile bond strengths(11,12) than fissures cleaned with rotary instrumentation and pumice.

Hydrogen peroxide (3%) also has been suggested for cleaning the occlusal fissures before etching, (14) but there is no evidence that this improves clinical retention.

Air abrasion also has been suggested for preparation of the occlusal surface before sealant application (15), which uses a high-speed stream of purified aluminum oxide particles propelled by air pressure to abrade the tooth surface. They can remove debris and excavate incipient decay in the fissures. A widening of the fissures with rotary instrumentation is yet another type of fissure conditioning that has been recommended before etchant and sealant application. This is known as the invasive pit-and fissure technique.(16)

Isolation of the tooth

Adequate isolation is the most critical aspect of the sealant application process. Salivary contamination of a tooth surface during or after acid etching will have a deleterious effect on the ultimate bond between enamel and resin.

The rubber dam, when properly placed, provides the best, most controllable isolation, and for an operator working alone, it ensures isolation from start to finish.

Some of its disadvantages include: discomfort during clamp placement, need for local anesthetic in some instances, difficulty in securely placing a clamp onto a partially erupted tooth, an increase in the cost and need for sterilization of the armamentarium

Cotton roll isolation offers some advantages over rubber dam isolation. No anesthetic is necessary because no clamps are placed. Cotton rolls can be held in place with either cotton roll holders or fingers. The primary disadvantage to cotton roll isolation is that it is almost a practical necessity that an assistant be used to provide four-handed dentistry.

Four-handed dentistry minimizes the placement time and also allows one set of hands to maintain primary focus on dryness, while the second set handles the materials and equipment.

The four-handed technique may improve the quality and efficiency of sealant placement through shortened placement time, improved isolation, reduction in operator fatigue and enhanced patient care.(17-19)

In comparison with two-handed delivery, four-handed delivery increased sealant retention by about 9 percentage points.
Another alternative to the rubber dam is the Vac-Ejector moisture control system, which consists of a bite block and rubber tongue shield that connect to the high-speed evacuation line, providing a clear, dry field for sealant procedures. Clinical studies have found that sealant retention with the Vac-Ejector, either with or without a chairside assistant, is comparable to that with sealants placed under rubber dam or cotton roll isolation. (20, 21)

Etch the enamel surface

There are various etchant materials available, but the most frequently used etchant is 37% orthophosphoric acid. This is available as both a liquid solution and a gel.

Many clinicians prefer to use a gel because it is easily applied and controlled and because of its color, easy to tell where it has been applied. The application of the gel is most often done either directly from the gel dispenser with special applicator tips or with a small disposable brush.

Others prefer the liquid etchant because it flows when it is applied to the surface and more readily covers the entire surface. Liquid etchant, likewise, is often applied by brush, although a small cotton pledget is acceptable.

One should always apply the etchant onto all the susceptible pits and fissures of the tooth and extend it up the cuspal inclines well beyond (at least 2 millimeters) the anticipated margin of the sealant.

Thoroughly rinse and dry the tooth

Many of the sealant manufacturers recommend rinsing the tooth for 20 to 30 seconds to remove the etchant. An exact rinse time is probably not as important as ensuring that the rinse is long enough and thorough enough to remove all of the etchant from the surface.

Drying the tooth with compressed air is done such that the tooth exhibits a chalky, frosted appearance but if still no frosted appearance is seen, the tooth should be re-etched for 15 to 20 seconds.

Apply the sealant

During sealant application, all the susceptible pits and fissures should be sealed for maximum caries protection. Some have suggested that a bonding agent be placed before the sealant is applied; however, this is of debatable value.

The long-term clinical success of fissure sealants is closely related to their poor handling (22). A dry enamel surface is necessary to achieve good adhesion. It is not easy to apply rubber dam in children without anesthesia and, also, cotton-roll isolation requires four-handed dentistry; moreover, in these conditions, contamination during swallowing and tongue movement is still possible(23).

The findings of this study showed that the use of bonding agent under fissure sealants on saliva-contaminated teeth is beneficial for microleakage reduction. In situations in which control of saliva and isolation is impossible, the use of bonding for increasing the quality of fissure sealant therapy is useful.

The sealant material can be applied to the tooth in a variety of methods. Many sealant kits have their own dispensers, some pre-loaded, that directly apply the sealant to the tooth surface. When using a dispenser, the dentist should allow the sealant to flow ahead into the crevices as the dispenser is advanced from one end of the tooth to the other. This minimizes entrapment of air bubbles. Sealant also may be applied with a small brush or on the tip of an explorer.

Some common problems occur during sealant application. Small bubbles may form in the sealant material. If these are present, they should be teased out with a brush before polymerization. Unfilled sealants have a low viscosity that makes them prone to pooling in the distal pit area of maxillary molars due to patient position and gravity. This can be rectified by applying the sealant judiciously or by removing excess amounts with a brush.

Polymerization

For lightcured sealants, polymerization should be initiated quickly after the sealant is placed on the etched surface to help minimize potential contamination. However, an interesting study by Chosack and Eidelman(24) found that the longer sealants were allowed to sit on the etched surface before being polymerized, the more the sealant penetrated the microporosities, creating longer resin tags, which are critical for micromechanical retention.

When autopolymerizing sealants are used, they should not be disturbed once the polymerization process has begun as that may incorporate voids in the material. After the sealant has set, wiping the sealant surface with a wet cotton roll or pellet will remove the air-inhibited layer of non-polymerized resin. If the surface is not wiped off, an unpleasant taste will develop.

Evaluate the sealant

The sealant should be visually and tactually inspected for complete coverage and absence of voids or bubbles. Small voids in the sealant can be repaired simply by adding new material to the void and polymerizing.

If sealant has pooled in the distal portion of the tooth or against a distal operculum, a ledge may exist that should be removed. An evaluation of the occlusion should be done to avoid leaving the patient with a sustained hyperocclusion.

It is also critical to evaluate the interproximal regions for inadvertent sealant placement. This can be done by tactile examination and by passing dental floss through the contact areas. If sealant is discovered here, usually it can be easily dislodged with the explorer or a scaler.

Periodic Evaluation

Regular evaluation of sealants for retention is critical to their success. During routine recall examinations, it is necessary to re-evaluate the sealed tooth surface both visually and tactually for loss of material, exposure of voids in the material and caries development. The need for reapplication of sealants is usually highest during the first six months after placement(25).When sealants are partially lost and require repair, the clinician should vigorously attempt to dislodge the remaining sealant material with an explorer. If it remains intact to probing, there is no need to completely remove the old material before placing the new.

Simply follow the usual sealant steps as outlined above, etching both the enamel and the remaining sealant and then applying additional sealant.

Success rates for the sealant restorations

According to Harris and Garcia-Godoy, 95% of all carious lesions occur on the occlusal surfaces of teeth. The occlusal surfaces of teeth comprise 12% of the total number of tooth surfaces, which means the pit and fissures of the occlusal surfaces of teeth are eight times more susceptible to decay as the smooth surfaces of the teeth.[26] The teeth at highest risk for carious lesions are the first and second molars, and 90% of all dental caries in school children occurs in pits and fissures of the

Occlusal surface of the molars(27)

One of the major problems when considering the success rates of sealant restoratons is the variation in techniques and materials used.

Short term studies indicate a high degree of success for sealant restorations(28-37).However, longer term studies appear to indicate that success is less predictable(38-43).For direct comparison of sealant restoration studies it is necessary to define success as 100% retention and no caries present in the tooth. Various studies conducted over duration of 1 year to 9 years showed a success rate ranging from 100% to 28 %(28-43).

Combined Effect of Sealant and Fluoride Rinsing Programs

The combination of sealant and fluoride rinsing programs significantly reduces the incidence and prevalence of pit and fissure and smooth surface caries in schoolchildren from fluoride-deficient communities. A longitudinal study compared the effect of fluoride rinsing alone with sealant placement combined with fluoride rinsing in caries-free second- and third-grade schoolchildren(Ripa et al.,1986,1987).After a 2-year period,78% of the children in the fluoride rinse group were caries-free. In comparison, 96% of children receiving the benefits of both fluoride rinsing and sealant placement were caries-free. The caries incidence in children in the fluoride rinse group was 13 times that noted in children in the combined fluoride-sealant group.

Challenges

Health promotion and disease prevention are goals of preventive health programs in the healthcare professions. Evidence shows health promotion, health education, health literacy, and disease prevention need to be combined for a general understanding of the public(44).Healthcare providers face challenges to provide safe and effective disease prevention measures that can be integrated into clinical, academic, and public health domains. There are many oral as well as general health disparities within the U.S. population (44) that have an impact on society. Reducing disparities requires improving access to care for targeted high-risk populations. The incorporation of risk assessment models of disease prevention into community-based public health programs and into private clinical practice would help target high-risk dental populations for appropriate interventions assessment(44).

Conclusion

Dental sealants are a proven tool in caries prevention. This review demonstrates that there is some degree of latitude in operator preferences for sealant placement and material selection. The geometry of the pits and fissures certainly influence the penetration of sealants. However, it is critical that tooth surfaces be well isolated and completely dry during the application process. Also that polymerization times be sufficient for complete polymerization and that sealants undergo routine periodic evaluation and be repaired as needed to ensure maximum caries prevention.

THE AUTHORS

Dr. J Avinash
Reader
Department of Preventive and Community Dentistry
Sudha Rustagi College of Dental Sciences And Research, Faridabad
E mail: aviandash@rediffmail.com

Dr. CM Marya
Professor and Head
Department of Preventive and Community Dentistry
Sudha Rustagi College of Dental Sciences and Research, Faridabad
E Mail: maryacm@yahoo.co.uk

Dr. S Dhingra
PG Student
Department of Preventive and Community Dentistry
Sudha Rustagi College of Dental Sciences and Research, Faridabad

Dr. P Gupta
Senior Lecturer
Department of Preventive and Community Dentistry
Sudha Rustagi College Of Dental Sciences And Research, Faridabad

Dr. S Kataria
Professor and Head
Department of Conservative and Endodontics
Sudha Rustagi College of Dental Sciences and Research, Faridabad

Dr. Meenu
Associate Professor
Department of Conservative and Endodontics
Sudha Rustagi College of Dental Sciences and Research
Faridabad

Dr. Hind Pal Bhatia
Professor
Department of Pedodontics,
Santosh Dental College & Hospital, Ghaziabad (UP)

References

1. Hyatt TP. Occulusal fissures: Their frequency and danger. How shall they be treated? *Dent Items Interest* 1924;**46**:493.
2. Bodecker CF. The eradication of enamel fissures. *Dent Items Interest* 1929;**51**:859.
3. Buonocore MG: Simple method of increasing the adhesion of acrylic filling materials to enamel surfaces. *J Dent Res* 1955;**34**:849.
4. Bowen RL. Composite and sealant resins-past, present and future. *Pediatric Dent* 1982;**4**:10.
5. Nagano T. Relation between the form of pit and fissure and the primary lesion of caries. *Dent Astr* 1961;**6**:426.
6. Grewal, N.; Chopra, R. The effect of fissure morphology and eruption time on penetration and adaptation of pit and fissure sealants: An SEM study. *J Indian Soc Pedod Prevent Dent* 2008:59-63 COPYRIGHT 2008 Medknow Publications Pvt. Ltd. This material is published under license from the publisher through the Gale Group, Farmington Hills, Michigan. All inquiries regarding rights should be directed to the Gale Group. (Hide copyright information)
7. Garcia-Godoy F, Medlock JW. An SEM study of the effects of air-polishing on fissure surfaces. Quintessence Int 1988;**19**:465-7.
8. Versterhus Strand G, Raada M. The efficiency of cleaning fissures with an air-polishing instrument. Acta Odontol Scand 1988; **46**(2):113-7.
9. Brocklehurst PR, Joshi RI, Northeast SE. The effect of air-polishing occlusal surfaces on the penetration of fissures by a sealant. *Int J Pediatr Dent* 1992;**2**(3):157-62.
10. Brockmann SL, Scott RL, Eick JD. A scanning electron microscopic study of the effect of air polishing on the enamel-sealant surface. *Quintessence Int* 1990;**21**(3):201-6.
11. Brockmann SL, Scott RL, Eick JD. The effect of an air-polishing device on tensile bond strength of a dental sealant. *Quintessence Int* 1989;**20**(3):211-7.
12. Scott L, Greer D. The effect of an air polishing device on sealant bond strength. *J Prosthet Dent* 1987;**58**:384-7.
13. Scott L, Brockmann S, Houston G, Tira D. Retention of dental sealants following the use of air polishing and traditional cleaning. *Dent Hyg* 1988;**62**:402-6.
14. Christensen GJ. Fluoride made it: why haven't sealants? *JADA* 1992;**123**(2):89-90.
15. Goldstein RE, Parkins FM. Air-abrasive technology: its new role in restorative dentistry. *JADA* 1994;**125**:551-7.
16. De Craene GP, Martens C, Dermaut R. The invasive pit and fissure sealing technique in pediatric dentistry: an SEM study of a preventive restoration. *ASDC J Dent Child* 1988;**55**(1):34-42.
17. Waggoner WF, Siegal M. Pit and fissure sealant application:updating the technique. *JADA* 1996;**127**(3):351-361.
18. Cooper TM. Four-handed dentistry in the team practice of dentistry. *Dent Clin North Am* 1974;**18**(4):739-753.
19. Robinson GE, Wuehrmann AH, Sinnett GM, McDevitt EJ. Fourhanded dentistry: the whys and wherefores. JADA 1968; **77**(3):573-579.
20. Wood AJ, Saravia ME, Farrington FH. Cotton roll isolation versus Vac-Ejector isolation. ASDC J Dent Child 1989;**56**:438-41.
21. Foreman FJ, Matis BA. Sealant retention rates of dental hygienists and dental technicians using differing training protocols. Pediatr Dent 1992;**14**(3):189-90.
22. Barroso JM, Lessa FC, Palma Dibb RG, Torres CP, Pecora J, Borsatto MC. Shear bond strength of pit and fissure sealants to saliva contaminated and non-contaminated enamel. *J Dent Child* 2005;**72**:95-9.
23. Bodur H, Tulunoglu O, Uctasli M, Alacam A. The effect of bonding agents on the microleakage and bond strength of sealant in primary teeth. *J Oral Rehabil* 1999;26:436-41.
24. Chosak A, Eidelman E. Effect of time from application until exposure to light on the tag lengths of a visible light-polymerized sealant. *Dent Mater* 1988;**4**:302-6.
25. Dennison JB, Straffon LH, More FG.Evaluating tooth eruption on sealant efficacy. *JADA* 1990;**121**:610-4.
26. Bohannan H, Caries Distribution and the case for sealants. *J Public Health Dentistry* 1983;33:200-204.
27. Harris N, Godoy-Garcia F. Primary Preventive Dentistry, 5th ed. Stanford, Connecticut: Appleton and Lange, 1999.
28. Simonsen RJ, Stallard RE. Sealantrestorations utilizing a dilute filled composite resin: one year results. *Quintessence Int* 1977;23:307-315.
29. Azhdari S, Sveen OB, Buonocore MG. Evaluation of a restorative preventive technique for localized occlusal caries. *J Dent Res* 1979;**58**(special issue A):330 Abstract 952.
30. Walker JD, Jensen ME, Pickham JR. A clinical review of preventive resin restorations. *ASDC J Dent Child* 1990;**57**:257-259.
31. Houpt M, Eidelman E, Shey Z, *et al.* Occlusal restoration using fissure sealant instead of 'extension for prevention', eighteen month results. *J Dent Res* 1982;61:214. Abstract 324.
32. Gray G B. An evaluation of sealant restorations after 2 years. *Br Dent J* 1999;186:569-575.
33. Walls AWG, Murray JJ, McCabe JF. The management of occlusal caries in permanent molars. A clinical trial comparing a minimal composite restoration with an occlusal amalgam restoration. *Br Dent J* 1988;164:288-292.
34. Simonsen RJ, Jensen ME. Preventive resin restorations utilizing a diluted filled composite resins: 30 months results. *J Dent Res* 1979;**58**(special issue A):330(abstract No.952).
35. Raadal M. Follow-up study of sealing and filling with composite resins in the prevention of occlusal caries. *Community Dent Oral Epidemiol* 1978;**6**:176-180.
36. Simonsen RJ. Preventive resin restorations. *J Am Dent Assoc* 1980;100:535-539.
37. Houpt M, Eidelman E, Shey EZ. Occlusal restoration using fissure sealant instead of 'extension for prevention'. *ASCD J Dent Child* 1984;51:270-273.
38. Houpt M, Eidelman E, Shey EZ. Occlusal composite restorations:4 year results. *J Am Dent Assoc* 1985;110:351-353.
39. Welbury RR, Walls AGW, Murray JJ, McCabe JF. The management of occlusal caries in permanent molars. A 5-year clinical trial comparing a minimal composite with an amalgam restoration. *Br Dent J* 1990;169:361-366.
40. Houpt M, Fuks A, Eidelman E. Composite/sealant restoration: 6.5 year results. *Paed Dent* 1988; 10: 304-306.
41. Simonsen RJ, Landy NA. Preventive Resin Restorations: fracture resistance and 7-year clinical results. *J Dent Res* 1984; **63**(special issue): 261(abstract No.175).
42. Houpt M, Fuks A, Eidelman E. The preventive resin (composite resin/sealant) restoration:Nine-year results. *Quintessence Int* 1994;25:155-159.
43. Mertz-Fairhurst EJ, Adair SM, Sams DR, *et al.*Cariostatic and ultraconservative sealed restorations: Nine-year results among children and adults. *J Dent Child* 1995;**62:**97-107.
44. US Department of Health and Human Services (USDHHS). Oral Health in America: A Report of the Surgeon General. Rockville, MD: U.S. Department of Health and Human Services, National Institute of Dental and Craniofacial Research, National Institutes of Health, 2000.