International Journal of Dentistry Research

Review Article

ISSN: 2581-3218
IJDR 2020; 5(2): 110-116
Received: 20-07-2020
Accepted: 16-08-2020

www.dentistryscience.com

Principles and Practice of Conservative Adhesive Restorations: A brief review

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Abstract

Dental caries has been recognised as a major public health problem globally which has an equivalent effect on all age groups. Caries predominantly affects the occlusal surfaces of erupting molars and premolars and thus accounts for nearly 80-90% of pit and fissure caries in permanent teeth. Apart from regular measures for management of dental caries preventive measures involving sealing of the cavitated and non cavitated pits and fissures can be promising tool for cost effective caries prevention. Conservative Adhesive restorations (CAR) have proven to be one such effective means in prevention and treatment of pit and fissure caries. This article reviews complete application technique of CAR along with its indications, contraindications, advantages, disadvantages. Also, literature-based review of the success rate has been reported. An insight of its application in children and advancements that can help in further improving the efficacy have also been reviewed. From this review and after discussion of recently published studies, it is evident that prophylactic techniques like CAR can be both preventive as well as therapeutic measure for preventing progression of incipient caries.

Keywords: Conservative Adhesive Restorations (CAR), Preventive resin restorations (PRR), Dental Sealants, Pit and Fissure Caries.

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INTRODUCTION

Dental caries has been rated as an important global oral health problem in the world today.[1] Despite of the great improvements in the oral health of population, dental caries still continues to affect oral health of all age groups and has been an area of major concern by dentists all around the globe. Great efforts have been made for achieving caries prevention by methods of diet counselling, fluoride application, motivation for oral hygiene maintenance and more accessible dental facilities. These methods have helped in controlling smooth surface caries but caries prevalence of pit and fissure caries still seems to be high.[2]

Pits & Fissures are naturally occurring depressions and clefts respectively which harbours carious bacteria and substrates, by virtue of their anatomic shape and are extremely susceptible to caries. These anatomical recesses not only encourage the spread of the lesion but also limits the access to salivary factors which helps to attenuate the process of demineralization and triggers remineralization.[2] While only 12.5% of the occlusal surfaces are pits and fissures they account for almost two third of the caries in human dentition.[3] Caries occurring in the pits and fissures account for 80% to 90% and 44% of the total caries in permanent teeth and primary teeth respectively.[4]

Historical Perspective

The earlier treatment strategies for preventing pit and fissure caries can be traced back to the 18th century when Hunter thought that physically blocking the pits and fissures can lead to caries prevention. Wilson, 1895 advocated the use of zinc phosphate as fissure filling material.[5] In the year 1905 Willoughby D.Miller applied an antibacterial agent silver nitrate onto the tooth surfaces to chemically treat the biofilm present.[6] Following these methods like prophylactic odontomy by T.P Hyatt in 1924, fissure eradication by Bodecker 1929 based on the concept of “extension for prevention” were introduced.[2] Then with the advent

of acid etch technique and adhesion concept by M.G Bunocore in 1955 revolutionary changes were seen. In the mid 1960's investigations using methyl cyanoacrylate as sealant material by Cueto were performed but the material was not marketed.[7] Then Bowen invented BISGMA (bisphenol-a-glycidyl dimethacrylate) a viscous resin which was proved to have good bonding properties to etched enamel by Bunocore in 1970. This bonding property thus lead to successful creation of dental sealants which then started emerging as an effective means for managing pit and fissure caries.[7,8]

Preventive resin restoration (PRR) is a conservative reply to 'extension for prevention' philosophy. PRR is a secondary prevention technique which allows to halt the progress of the carious lesion at its incipient stage and thus prevents further decay.[9] The strategy integrates the preventive aspect of occlusal sealant therapy for caries susceptible pits and fissures with the therapeutic restoration of incipient caries that occur in the same occlusal surface with composite resin. These restorations are now termed as **"Conservative Adhesive Restoration" (CAR)** to reflect the fact that other adhesive material may be utilized in these restorations.[2] This updated term was first described by Simonsen and Stallard in 1977 [10] and refined in 1985.[11]

DEFINITION

Preventive resin restoration is a conservative treatment that involves limited excavation to remove carious tissue, restoration of the excavated area with a composite resin, and application of a sealant over the surface of the restoration and remaining, sound, contiguous pits and fissures.[12]

TYPES

It can be classified in 3 categories based on the extent and depth of carious lesion as determined by exploratory preparation. Simonsen [13] has classified them as:

TYPE A

Suspicious pits and fissures where caries is limited to enamel only (Figure 1A). Local anaesthesia is not required. A slow speed ¼ or ½ round bur or air abrasion technique can be used for caries removal. Sealant is then flown onto the prepared and acid-etched surface. [14]

TYPE B

Carious lesion that extend substantially into enamel or even into dentin but are limited to pits and fissures and are small and confined; can be removed using size 1 or 2 round bur and can be restored by placing a flowable resin based composite material to replace the lost tooth structure followed by sealant placement over the entire occlusal surface to prevent further decay (Figure 1B).

This conservative method of caries prevention is now frequently termed as "Microdentistry".[14]

TYPE C

More extensive carious lesion with dentinal involvement that requires removal using a bur size larger than 2. An appropriate base is placed over dentine followed by restoration with conservative resin composite material. Pits and fissures are then covered with a sealant. Use of local anaesthesia is required (Figure 1C).

TECHNIQUE

A number of methods for preventive resin restorations with minor differences have been described in the literature. All of these methods can be accomplished using the following common treatment sequence [12] -

(1) Anaesthesia and isolation

(2) Preparation

(3) Restoration

(4) Sealant application

In Detail Technique (Figure 2) –

1. Administering local anaesthesia

Although optional, infiltration or block anaesthesia should be considered for the patient's comfort.

Rationale- Although minimal instrumentation is associated with the procedure but sometimes excavation with high-speed burs may be painful and also application of the rubber dam retainers might be perceived painful by some patients and thus use of local anaesthesia plays an important role.[12]

2. Isolation

Only the tooth or teeth being treated needs be isolated.

Rationale - A procedure involving conditioning with acid, application of composite resin and sealant, and possible use of glass-ionomer lining cement is technique sensitive and time consuming. Each of these steps is sensitive to moisture contamination and thus use of rubber dam becomes a mandatory step to prevent salivary contamination of the concerned tooth.[12]

3. Caries Removal

A small pear-shaped, or round-ended bur is used. The cavosurface margin is not bevelled.

Rationale- There are no rules of cavity design as this is a bonded restoration and the main purpose remains of caries removal with minimum tooth structure loss. Penetration beyond the dentoenamel junction is not necessary, if all caries has been removed. Small burs are used to conserve tooth structure and help ensure a narrow cavity preparation. Bevelling of the cavosurface margin is not required as it has no significant effect on the clinical performance of posterior composite resins.[15]

4. Providing pulpal protection if necessary

Calcium hydroxide is placed only on the floor of the preparation. Glass-ionomer lining cement (GIC) should cover all of the dentin and not extend onto the enamel.

Rationale- If the excavation extends close to the pulpal tissue, i.e. in cases where remaining dentinal thickness in between the floor of the cavity preparation and the pulp is ≤ 0.5 mm, calcium hydroxide liner is recommended. Calcium hydroxide slightly demineralizes dentine, and releases transforming growth factor-β1 from the matrix that signals tertiary dentinogenesis. This is responsible for repair in dentine pulp complex and helps stimulate reparative dentin formation when the preparation approaches the pulp.[16]

Glass-ionomer lining cement bonds to dentin and has the advantage of micromechanical penetration into the tooth. Other advantages of using GIC as liner is that it has almost similar coefficient of thermal expansion as tooth, thereby reducing microleakage and postoperative sensitivity. Fluoride releasing ability helps in formation of fluorohydroxyapatite crystals which makes tooth more resistant to demineralization. GIC expands slightly on contact with moisture which may compensate for polymerization shrinkage of the resin composite and thus reduce

microleakage.[17] Shallow preparations in dentin should be lined only with glass ionomer cement. Preparations that are limited to enamel do not require a liner.

5. Cleaning the occlusal surface

Prophylaxis using aqueous slurry of fine pumice in a rotating rubber cup or fluoridated/non fluoridated paste is done to clean the occlusal surface, including the cavosurface margin. The tooth is then washed and dried.

Rationale- Maximal bond strengths are obtained when a prophylaxis is given prior to acid conditioning. Studies have clearly shown that prophylaxis using pumice or other fluoridated pastes does not have a significant influence on the bond strength of the composite resins.[18]

6. Conditioning the entire occlusal surface

The surface, including the cavosurface margin and enamel cavity walls, is usually etched with 37% phosphoric acid gel or liquid then thoroughly washed and dried.

Rationale- Etching of the tooth surface is a key moment in the preparation of the tooth for application of adhesive restorations. Conditioning creates pores in the enamel and enables the microscopic infiltration of resin into the dentinal tubules, where it polymerizes and bonds and leads to formation of "resin-tags". [19]

Conventional recommendation time for etching enamel surface was 60 seconds but now different etching time ranging from 15 seconds to 60 seconds have been recommended. The difference in etching timings does not have a significant effect on the retention of the fissure sealant therefore it might be prudent to etch the teeth for shorter time period than conventional recommendation.[20,21] The tooth is then rinsed for about 30 seconds and air dried for about 15 seconds. This process removes all the residual acid etchant and helps to achieve the characteristic chalky white enamel frosty appearance.[22]

7. Placement of bonding agent

The cavity walls and surface of the glass-ionomer cement liner are covered with a bonding agent.

Rationale- Use of a bonding agent improves the bond strength between a GIC and composite resin. The bond strength of resin composite GIC is enhanced when a self-etching primer is applied over unset GIC or when a glass-ionomer based adhesive is applied over set GIC when compared to using a total-etch adhesive.[23] If the cavity preparation is limited to enamel, and glass-ionomer cement is not used, a bonding agent is still employed to improve the bond strength of composite restoration.[12]

8. Placement of posterior composite resin into the preparation

Two different techniques of posterior composite restoration can be used i.e. Layering technique or the Bulk Fill technique.[24]

Rationale- The composite resin micromechanically bonds to the conditioned enamel and provides an effective marginal seal. Bonding occurs between the composite resin and prepared glass-ionomer cement and dentinal walls.[12]

In layering technique light cured composite are placed in increments of about 2mm and cured. The major advantage of this technique is that the use of incremental layers helps to decrease the stress generated by resin composite polymerization shrinkage and also working in increments helps to simulate different opacities, shades, and translucency characteristics of enamel and dentin.

The bulk fill technique involves placement of low shrinkage bulk fill composites upto 4 -5 mm depending on manufacture's instruction. Two consistencies are available for the bulk-fill composites: flowable consistency (used as a base or liner) and regular consistency (used to fill and restore in one shot).[24]

9. Sealant application

The acid-conditioned occlusal surface and the restoration surface are then covered with sealant, which is either hardened by chemical cure or light cure. After the curing process is over retention and coverage of the sealant are checked. If sealant can be dislodged from the pits or fissures with an explorer, the tooth and restoration are again re-etched for 10 seconds, washed, and dried, and new sealant is applied.[12] Also sealants are checked for any voids or bubbles and for any deficient or excess material placement.[20]

Rationale- Sealant application helps to prevent caries of the pits and fissures that were not included in the cavity preparation. Also, this laminate technique of sealant application over composite resin or glass-ionomer cement helps minimizing microleakage.[12]

10. Occlusal Equilibration

The occlusion is equilibrated after rubber dam removal, particularly when semi filled sealants are used.

Rationale-Unfilled sealants wear off quickly whereas semi filled sealants are more abrasion resistant and thus require removal of high points.[12]

Teeth that can be sealed –

1. Teeth which have small and discrete carious lesions in pit and fissure with a 'catch'
2. Teeth having deep pits and fissures with minimal areas of decay.[25]

Teeth that cannot be sealed-

1. Teeth with large single-or multi-surface carious lesions, or pit and fissure lesions involving proximal surface of the tooth. [25]
2. Cases where proper tooth isolation is not feasible.[14]

ADVANTAGES

1. Minimal tooth preparation required, leaving behind a much stronger sound tooth structure.
2. Helps eliminate chances of marginal leakage and secondary decay.
3. Helps to prevents decay in adjacent pits and fissures without fissure removal.
4. More comfortable for the patients as seldom requires anaesthesia and also less number of visits are involved.
5. Repair of restoration is possible.

DISADVANTAGES

1. Technique sensitive i.e. requires strict adherence to principles of acid etching and also absolute moisture control is needed.
2. Long term retention needs to be determined still.

SUCCESS RATE

A number of studies pertaining to the longevity and survival of fissure sealants have been done over a period of time. The retention of the sealants placed above the restoration plays a very pivotal role in caries

prevention. Table 1 below shows the success rate i.e. complete retention rate of sealants in various studies done across the globe.

APPLICATIONS IN CHILDREN

The chances of a tooth developing caries is highest when it starts erupting in the oral cavity especially permanent first and second molars during their eruption phases are more vulnerable to this. A number of reasons can be attributed for erupting molars being at higher risk of developing caries like absence of opposing teeth leading to more chances of plaque accumulation, longer eruption period of about 1.5 years can lead to operculum covering, a plaque retention area and can promote caries initiation, Also, children find it difficult to maintain proper oral hygiene especially in areas of molars because of their posterior most position in the arch.[29,40] The occlusal surface of molars is responsible for about 67 - 90 % of caries in children of 5-17 years of age.[41]

Therefore, adopting methods of minimal intervention like Conservative Adhesive Restoration can be an effective means to prevent caries in both areas which are undiagnosed or susceptible and also where caries initiation has occurred. Areas covered with sealants act as physical barrier restricting access of fermentable carbohydrates to microorganisms thus inhibiting their cariogenic potential. The longer the sealant retention the effective the prevention as lower is the bacterial concentration.[42]

ADVANCEMENTS

The long-term effectiveness of CAR is mainly dependent on sealant material used and technique of application. Advancements in the quality and type of sealant material used and technique can assure long term clinical success. Some recent advances in this aspect are –

1. **Fluoride Releasing Sealants** – Sealants containing fluoride releasing flowable resins have proved to be more effective than conventional fissure sealants in arresting caries progression as concluded in study done by Yan WJ *et al* in 2018.[43]

2. **Moisture Tolerant / Hydrophilic Sealants** – Conventional sealants are hydrophobic in nature and are quite technique sensitive as they require complete dry field for placement. Hydrophilic sealants like Embrace Wet Bond have proven to be more effective in a 2-year clinical trial study done by Ratnaditya A *et al* in 2015.[44]

3. **Nanofilled Resin Sealants** – Nanocomposites as sealants exhibit greater penetration depth when compared to conventional resin sealants and also exhibits lesser microleakage. Their use is highly recommended in pediatric dental patients by Singh S *et al* in their study conducted in 2011.[45]

4. **ACP Containing Sealants –** Amorphous Calcium Phosphate (ACP) containing sealants exhibits remineralization properties as ACP in acidic environment releases calcium and phosphate ions leading to their supersaturation within carious lesions and hence formation of apatite crystals takes place. Their superior retention and caries preventive effect have been reported in studies done by Khatri SG in 2019 [46] and Choudhary P in 2012.[47]

5. **Resin Infiltration System –** The placement of sealants through this technique have shown better penetration depths, maximum microhardness and minimum surface roughness when compared to conventional technique. This can be considered as promising non-invasive approach for caries prevention especially in paediatric patients.[48]

6. **Self-Adhering flowable composites as sealants**- Composites like Vertise Flow (Kerr, USA) does not require any acid etching or bonding procedure before application. Such composites have shown to have lesser microleakage, better marginal adaptability and are therefore less time consuming and technique sensitive making their use more effective in children and patients with high salivary flow.[49]

Table 1: Success rate i.e. complete retention rate of sealants in various studies done across the globe

Author (year)	Study Duration	Age Group Studied	Tooth sealed	Success Rate (Total Retention)	Caries recurrence rate in sealed tooth
Prathibha B. *et al* (2019)[26]	1 year	7-9 Years	Mandibular 1st molars	75.7%	5.4%
Pandiyan N.J. *et al* (2016)[9]	2 years	6-10 Years	Permanent 1st molars	62.2%	18%
Rezvan Rafatjou *et al* (2014)[27]	1 year	7-13 Years	Maxillary & Mandibular 1st Molars	53.6%	-
Ulusu T *et al* (2012)[28]	2 years	7-15 Years	Permanent 1st molars	20.8%	4.8%
Antonson SA *et al* (2012)[29]	2 years	5-9 Years	Partially erupted maxillary or mandibular 1st molars	40.7%	-
Baseggio W *et al* (2010)[30]	3 years	12-16 Years	Permanent Second Molars	91.08%	8.91%
Subramaniam P *et al* (2008)[31]	1 year	6-9 Years	Permanent First Molars	14.6%	-
Poulsen S *et al* (2001)[32]	3 years	7 Years	Permanent First Molars	74.15%	4.4%
Gray GB (1999)[33]	2 years	-	Permanent Second Molars	92%	10.9%

Forss H *et al* (1998)[34]	7 years	5-14 Years	Permanent First & Second Molars	45%	16.5%
Raadal M *et al* (1996)[35]	4 years	6-7 Years & 12-13Years	Permanent First & Second Molars	97%	0 %
Walker J *et al* (1996)[36]	1.5 years (median time)	5-18 Years	Permanent Molars & Premolars	88.3%	8%
King NM *et al* (1996)[37]	7.6 months (mean value)	-	Permanent Molars	28.4%	2.3%
Forss H *et al* (1994)[38]	2 years	5-14 Years	Permanent Molars	82%	4.6%
Houpt M *et al* (1994)[39]	9 years	6-14 Years	Permanent Molars	54%	25%

Figure 1A

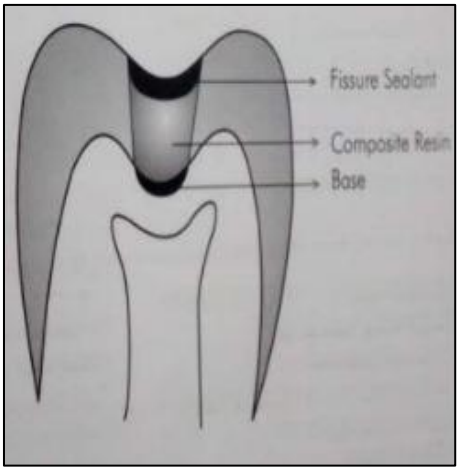

Figure 1B

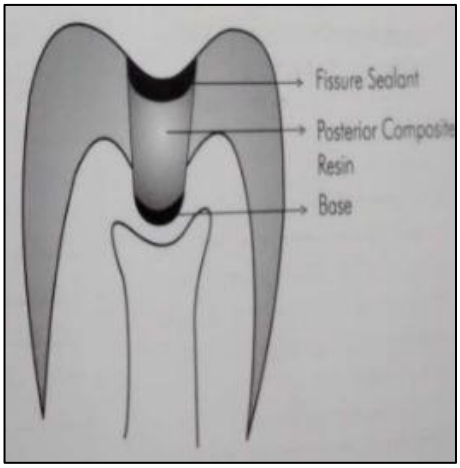

Figure 1C

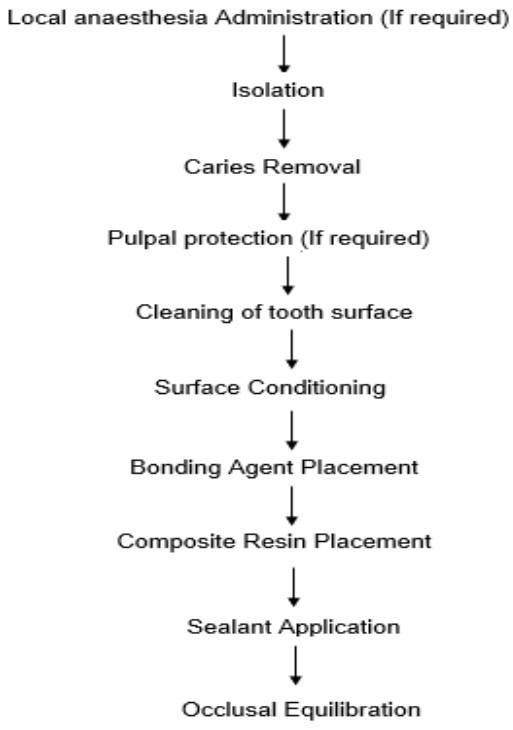

Figure 2 : Flowchart Summarizing Indetail Application Technique

CONCLUSION

Conservative Adhesive Restorations can be an efficient treatment for prevention of pit and fissure caries. If the treatment protocols are followed in a systematic manner long term results are expected. Also recall visits play a pivotal role in success of such restorations. Such preventive measures along with other oral hygiene practices can be very helpful in dental caries prevention.

Financial Support

Nil.

Conflict of Interest

The authors declare no conflict of interest.

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