

Effectiveness of Fissure Sealant in the Management of Non-Cavitated Occlusal Caries in Permanent Molars. A Systematic Review

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Abstract

The aim of the present review was to assess the effectiveness of Resin-Based Fissure Sealant (RBFS) in the management of pit and fissure occlusal caries in permanent molars in terms of arresting the caries process and improving the tooth prognosis compared to conventional restorative approach. The Medline/PubMed, Scopus and UOM Dentistry and Oral Sciences Source Databases were searched for clinical trials and/or review studies relevant to the topic. Results revealed that available evidence suggests that sealants can prevent the progression of early non-cavitated carious lesions and can replace the invasive restorative approach. However further clinical trials with longer follow up is recommended in order to strengthen the available evidence and to set a practical guidelines on the specific criteria of cases that can be safely managed with fissure sealant rather than restoration.

Keywords: *Fissure Sealant; Composite Restoration; Occlusal Caries*

Abbreviations

DPBRN: Dental Practice-Based Research Network; RBFS: Resin-Based Fissure Sealant; UOM: University of Manchester

Introduction

Treatment strategies for primary caries lesions have been undergoing continuous review and changes during the past decades. For more than 40 years dentist worldwide have been using operative technique and composite resin to directly restore carious teeth. However despite the advanced innovations and enhanced material properties to a highly sophisticated level, the survival statistics for direct restorations are far from encouraging. It must be stressed that with any restorative procedure, an irreversible cycle of restoration replacement and repair begins with every operative intervention [1-3] and all restorations are vulnerable to caries recurrence, material failures, and technical deficiencies, which increases the risks for adverse effects to the pulp and adjacent teeth and consequently affect the long term prognosis of restored dentition [4].

Based on these scientific facts and the increased understanding that caries process that can be arrested by several non-operative methods, treatment strategies of occlusal caries have been changing from operative to non-operative/preventive approach [5].

Pit and fissure sealing is a non-invasive evidence based approach that has been in use since 1960s to prevent caries development and clinical trials and reviews shows strong evidence for the effectiveness of resin based sealant for preventing dental decay in permanent molars [6-10]. The increasing tendency towards non-operative strategy to manage caries teeth along with evidence based knowledge about inconsistent long term survival rate of restorative treatment led to further clinical studies to investigate the use of resin sealants not only for preventing caries but also as a non-operative management of developed occlusal caries lesion. The present review aims to assess the evidence supporting effectiveness of light-cured resin-based fissure sealant (RBFS) in the management of pit and fissure occlusal caries in permanent molars in terms of arresting the caries progression in comparison to the conventional treatment method cavity preparation and filling approach.

Materials and Methods

The Medline/PubMed, Scopus and UOM Dentistry and Oral Sciences Source Databases were searched for studies relevant to the topic. The focused question was "Can the pit and fissure sealant effectively arrest the caries progression in non-cavitated occlusal caries in permanent molars".

The MeSH terms used for the Population were: dental caries OR "occlusal caries" OR "pit and fissure caries" OR "Pits and Fissures caries" OR "pit and fissure caries" OR "pits and fissures caries" OR "pit and fissure caries" OR "non-cavitated occlusal caries" OR "non-cavitated pit and fissure caries" AND "Adolescents" OR "Permanent molars".

Intervention terms were: "sealing" OR "sealant" OR "pit and fissure sealnt" OR "resin sealnt" OR "resin-based fissure sealant".

Outcome: Arrested caries OR arresting caries OR caries progression OR regression.

The search limits were set to English language, Human, Publication date from 2000 to 2017 and only clinical trials or reviews.

Results and Discussion

The search identified 47 articles in PubMed, 32 articles in UOM library database and 29 articles in Scopus. 26 duplicate publications were excluded leaving 82 potentially eligible articles. Screening of the titles and abstracts to evaluate the relevance of the articles to the proposed research topic identified that 9 publications were eligible to full text critical analysis.

Summary of the selected studies included for the review could be found in (Table 1).

Author	Study design	Aim of the study	Sample size	Duration/Follow up	Outcome measurement	Findings/Results
Wright, <i>et al.</i>	Systematic review	Summarize the available evidence regarding the effect of dental sealants for the prevention and arresting of pit-and-fissure occlusal caries in primary and permanent molars on children, adolescents	23 Clinical trials: 14 parallel design 9 Split-mouth RCT	Included studies that were published from 1971 to 2016	Odds Ratio (OR) Relative Risk (RR) Assessment of the quality of evidence by using: Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach.	Moderate-quality evidence suggest that the use of sealants when compared with control groups that did not have sealants reduces the incidence of carious lesions in permanent molars by approximately 80% -When compared with fluoride varnishes, sealants still were associated with a reduction in the incidence of carious lesions of approximately 70%,but , in this case, was supported by low-quality evidence
akhshandeh Qvist, <i>et al.</i>	Clinical Trial	Assessment of effectiveness of Resin -based fissure sealant in arresting occlusal caries compared to composite restoration	Experimental (sealant) group =60 permanent molars Control group=12 composite restorations	6-12-mo intervals for 36 month	Clinical and Radiographic examinations	11 sealed teeth lost to follow up. Sealant arrested most of lesions (44/49) -All 12 restorations functioned well
Borges, <i>et al</i>	Split -Mouth Randomized Clinical trial	Efficacy of fissure sealant in managing non-cavitated dentin occlusal caries Compared with conventional composite restorations	60 primary molars in 30 subjects -Experimental (fissure sealant)=30 molars Control (composite restorations)=30 molars	12 month	Clinical and radiographic examination	Both treatment modalities were found to be similarly effective in managing no-cavitated occlusal caries. Efficacy in the sealant group were 91% and in the control group were 100%.
Borge, <i>et al</i>	Randomized controlled clinical trial	To evaluate Arrest of non-cavitated dentinal occlusal caries by sealing pits and fissures	Sixty permanent molars Experimental(Fissure sealant) group=30 molars Control (OHI)group=30	Four Month interval for 36 month but control group followed only for 8 month	Clinical and radiographic examination to detect caries progression	Large drop out of all of control group at 8 month due to caries progression Fissure sealant arrested caries in 88.5% of experimental group Conclusion: Pit and fissure sealant effectively arrested carious lesions
Da Silveira, <i>et al</i>	Randomized controlled clinical trial	To evaluate the efficacy of a nonsurgical approach to arrest occlusal non-cavitated dentin lesions through glass ionomer(GI) sealing.	51 teeth with clinically non-cavitated occlusal caries Experimental group=27 molars sealed with GI Control group=24 molars not submitted to any clinical intervention	12 month	1-clinical and radiographic examination to monitor caries progression 2-clinical examination to evaluate marginal integrity of the GI sealant	11% of molars in the experimental (GI) group shows caries progression compared to 50% in the control group 59% of the sealed molars required sealant replacement due to loss of marginal integrity A glass ionomer sealant may not be sufficiently effective in arresting caries progression
Wendt, <i>et al</i>	Cohort study	Retention of Fissure sealant placed in caries- free permanent first and second molars	54 subjects : 153 sealed permanent first molar 161 Second molar	1977 to 1997	Clinical examination to detect: 1-Complete retention 2-Partial retention 3-Caries or restoration	First molars showed : -65% complete retention -22% Partial retention -13% caries or restoration Second molars showed : - 65% complete retention -30% partial retention -5% caries or restoration
Muller-Bolla, <i>et al</i>	Systematic review	Retention of Resin-Based Fissure Sealants(RBSs)	clinical trials of which 75% were split-mouth design Only caries free molars Population minimum age of 5 years	Included studies from 1965 to 2004	Relative Risk (RR) Meta-analysis	Light-cured RBSs had a significantly higher retention rate than Fluoride-containing light-cured RBSs at 48 month follow up (RR=0.80 95% CI: 0.72-0.89)
Valeria V Gordan, James D Bader, <i>et al.</i>	Cross sectional survey	Quantify dentists decisions about occlusal caries treatment thresholds	517 Dentists who have enrolled in the DPBRN	2010	Questionnaire which included a photograph of an occlusal surface displaying typical characteristics of caries penetration	63% of dentists who involve in the study would restore teeth with caries lesion located in inner enamel and 90% of dentists would surgically restore teeth with lesions located in outer dentine surfaces
Kakudate Sumida, <i>et al.</i>	Cross Sectional Study	Quantify dentists' treatment thresholds for occlusal primary caries	282 dentists in Japan affiliated with DPBRN	2014	Questionnaire which included a photograph of an occlusal surface displaying typical characteristics of caries penetration	Over one-third of participants chose to intervene surgically and restore teeth with inner enamel occlusal carious lesions

Table 1: Summary of studies included in the literature review.

Wright, *et al.* in 2016 [11] conducted a systematic review of the literature on effectiveness of pit and fissure sealant. The purpose of this review was to summarize the available evidence regarding the effect of dental sealants for the prevention of pit-and-fissure occlusal caries in primary and permanent molars on children, adolescents, and adults compared with a control without sealants, with fluoride varnishes, or with another head-to-head comparison of identified 4 types of sealants:

1. Resin-based sealant,
2. Glass ionomer cement,
3. Polyacid -modified resin sealant (Compomer)
4. Resin-modified GI sealant

The review included 24 articles representing 23 trials (9 parallel design and 14 split mouth randomized clinical trials (RCTs) published from 1971 to 2016) involving participants age 3 - 16 years old with sound or carious permanent first molars and included at least 2 years of follow up.

The results of this systematic review revealed a moderate quality evidence to suggest that children and adolescents who receive sealants in sound occlusal surfaces or non-cavitated pit-and- fissure carious lesions in their primary or permanent molars (compared with a control without sealants) experienced a 76% reduction in the risk of developing new carious lesions after 2 years of follow-up.

When sealant compared to fluoride varnish, results showed that pit and fissure sealant still were associated with a reduction in the incidence of caries of approximately 70%. However, in this case, the evidence assessed as low quality evidence.

Moreover, Wright, *et al.* [11] reported that the quality of the evidence decreased to low or very low for most of the outcomes measured related to the head-to-head sealant comparisons of the effect of different sealant materials on caries incidence and retention loss and further research is needed to provide information about the relative merits of the different types of sealant materials.

Bakhshandeh, *et al.* [12] conducted a comparative RCT focusing on the effectiveness of fissure sealant placed on 60 molars with occlusal caries, whereas in the control group 12 composite restorations were placed. Based on the results that sealant arrested most of the carious lesions, the authors recommended expansion of criteria for therapeutic sealing of occlusal carious lesions [12]. Prominently there is a remarkable disproportion in group sizes between experimental and control group: 5 to 1, which could affect the dependability of their findings.

One year earlier, another study to compare fissure sealant with direct composite restorations showed that pit and fissure sealant was as effective as composite in management of occlusal caries lesions was conducted by Borges, *et al.* [13], however the study was limited only to a short follow up period of 12 months.

Further investigation carried out by Borges and co-researchers to investigate the caries progression beyond resin based fissure sealant placed on the occlusal surface of (30) permanent molars with non cavitated carious lesions compared with a control group of 30 molars of oral hygiene instruction. The study revealed that fissure sealant effectively arrested carious lesions for 36 months [14]. The study quality is questionable, because although the selected patients were at high risk for caries, patients in the control group (30 molars) were given oral hygiene instructions only and were followed for only 8 months due to signals of caries progression leading to a large drop-out.

Earlier, a RCT was conducted by da Silveira, *et al.* [15] to investigate caries progression and sealant loss. The sample size of 51 permanent molars in 38 subjects of mean age 13 years old diagnosed with non-cavitated occlusal caries was comparable to the sample sizes in the studies by Bakhshandeh, *et al.* [12] and Borges, *et al.* [14], da Silveira, *et al.* [15] stived for an equal allocation ratio and as a result 27 molars were sealed with self cure glass ionomer (intervention) in comparison to the control group of 24 molars that were submitted to oral hygiene instruction without any clinical intervention. Caries progression was measured by clinical and radiographic examination at 4 months intervals for 12 months. Control group followed for 8 months only due to signals of caries progression (large dropout). Although sealed teeth showed no signs of caries progression on radiographic examination, they exhibited visible cavitation adjacent to the sealant after 12 month follow up.

Pit and Fissure sealants act as a barrier and cut off the access of surviving caries producing bacteria from their source of nutrient and any partial or complete loss of sealant will cause oral fluids to get into the fissures potentially increasing the risk of caries. Thus sealant retention is essential in maintaining a sealant caries -preventive effect [16,17]. Therefore many studies explored the retention of pit and fissure sealant with regard to different types of sealants and clinical techniques used for sealant application as well. In 2004 Muller-Bolla, *et al.* [18] performed a systematic review on the retention of resin-based sealants (RBSs), which included 31 studies. It is important to note that 75% of these studies had a split-mouth design. Results showed that Light-cured RBFS had a significantly higher retention rate than Fluoride-containing light-cured RBFS at 48 month follow up (RR = 0.80 95% CI: 0.72 - 0.89) Also concluded that the use of rubber dam for isolation significantly enhanced the retention of Light-cured RBFS.

Wendt, *et al.* [19] conducted an invaluable cohort study to investigate the long term retention of pit and fissure sealant after 15 - 20 years. The population consisted of 72 children each of their caries free four first permanent molars were sealed between 1977 and 1980 and later on, all caries free newly erupted second molars were sealed. at the follow up when the subjects were 26 - 27 years of age. The attrition rate was 37.5% higher than the standard rate of 20%, however Wendt, *et al.* [19] accounted for the drop-outs indicating that, 27 subjects moved away from the community. Only 45 subjects were still available with 153 first molars and 161 second molars. At the follow up examination of the first molar 20 years after sealant, 65% showed complete retention, 22% showed partial retention without caries and 13% showed caries or restoration. At the 15 years follow up of the second molars, 65% showed intact sealant, 30% partially intact and 5% of second molars showed caries or restoration.

Although many studies investigated the retention of fissure sealant and the results are encouraging, but the majority of the researchers focused on the retention of pit and fissure sealant applied to a sound, caries free molars. Retention of sealant placed in molars with non-cavitated carious lesion might be quite different because of characteristic changes of enamel due to demineralization caused by the caries process which might influence bonding strength between sealant and enamel surface.

It is worth noticing that there are a great variations among dentists all around the world in treatment strategy for occlusal primary caries. Valeria, *et al.* [20] carried out a cross sectional survey study aimed at investigating and quantifying the carious lesion depth at which dentists intervene surgically. These outcome were measured by a questionnaire, which included a photograph of an occlusal surface displaying typical characteristics of caries penetration. The questionnaire administered to the study population that were 517 dentists working in an outpatient dental practices who have enrolled in the Dental Practice-Based Research Network (DPBRN) which has the advantages of a broad representation of practice types, treatment philosophies' and patient populations. The study reported that 63% of dentists involved in the study would restore teeth with caries lesion located in inner enamel and 90% of surveyed dentists would surgically restore teeth with lesions located in outer dentine surfaces even if the patient was at low risk of developing caries. Similar cross sectional survey study conducted in Japan by Kakudate, *et al.* [21] which involved 282 dentists affiliated with DPBRN. The study demonstrated that over one-third of participants chose to intervene surgically and restore teeth even those teeth with caries lesion limited to inner enamel.

Conclusion

Although available studies suggest that fissure sealant is effective to arrest non cavitated occlusal dentinal caries but this review shows some limitations with these earlier studies, for instance short follow up periods, different sample size between intervention and control groups and large drop-out frequencies in the control group.

Furthermore, high percentage of dentists still preferred to make restorative treatments to manage non-cavitated occlusal caries. For these reasons it would be prudent to undertake further studies to close the gaps in the previous studies such as quality of evidence, assessment of retention of sealants placed in molars with non-cavitated caries rather than sound teeth, to evaluate effectiveness of sealant compared to restoration rather than comparison versus sealant free control group which might be ethically questionable due to increased risk of caries progression.

The findings of the recommended studies should fill the gap between the evidence and current practice and present an evidence based resource which can be considered by dentists in the clinical decision making process for the management of non-cavitated occlusal caries lesions.

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