

# SEALANTS IN DENTISTRY: A SYSTEMATIC REVIEW OF THE LITERATURE

R. CONDÒ, A. CIOFFI, A. RICCIO, M. TOTINO, S.G. CONDÒ, L. CERRONI

Department of Clinical Sciences and Translational Medicine - University of Rome "Tor Vergata"

## SUMMARY

The occlusal surface is the most affected area by dental caries and the sealing of the pits and of the fissures has been found, in time, the preventive method most effective trying to counteract the onset. Currently, the WHO considers it as a primary preventive measure, in other words one of the most effective and least invasive available to ensure the complete protection and the total preservation of the occlusal carious by the phenomenon.

**Purpose.** The aim of this work has been to perform a systematic review of the literature on clinical trials of different sealing materials, in order to: compare their individual characteristics, highlight the reliability and the long-term efficacy and identify the most significant variables, both technological and clinics, in order to declare whether or not the success of this method prior.

**Materials and methods.** The research has been carried out in the MEDLINE database by choosing keywords as "sealants" and "follow up". Only studies published in the last thirteen years have been considered and have been evaluated only types of scientific articles that fall within the definition of Anglo-Saxon "Clinical Trial" and "Controlled Clinical Trial", excluding all experimental works *in vitro*, case-reports, meta-analyses and literature reviews. Have been also considered only scientific papers on patients between the ages of 0 and 18 years.

**Results.** Out of 29 studies, evaluating a total of 2900 individuals (aged between 2.5 and 17 years), 7411 seals made by using resin-based sealants (RB Sealants), modified glass ionomer sealants (RMGI) and compomer sealants have been analyzed. The best retention capacity of the material in time has been obtained from the use of RB Sealants compared to RMGI, demonstrating retention values much lower with partial loss of material at a distance of one year from the clinic. The compomers demonstrate retention values intermediates. The incidence of caries in a year is negligible for all sealants application.

**Conclusions.** In terms of retention, resin-based sealants (RB Sealants) are the materials that give more guarantees of success at 12 months, while in the same period there haven't been significant differences in caries prevention of disease among the various classes sealing materials analyzed.

**Key words:** sealants, caries prevention, systematic review.

## Introduction

Because of the anatomy often deep and winding, the pits and the fissures are considered the areas at greatest risk of dental caries incidence because in these areas, the control of the accumulation and the removal of bacterial plaque, results to be often difficult if even unsatisfactory (1). A recent review of the literature shows that about 90% of carious lesions comes from pits and fissures in the occlusal surface of the posterior elements (2). Indeed the elements most susceptible for histological and morphological characteristics, are the

permanent molars, premolars and deciduous, with grooves between the cusps in the whose depth the enamel has a lower thickness, degree of mineralization and a delayed maturation than in the rest of the crown (3). Furthermore, the complicated morphology of these sites does not allow to adequately retain the molecules of fluorine, favoring the formation of seats of least resistance to acid attack of bacterial plaque (3).

Being then the occlusal surface of the dental area most affected, the sealing of pits and fissures has been found, in time, the prior method more effective to tackle the onset of occlusal caries (4). Currently, indeed, the WHO considers the seal as the primary preventive measure, one of the most effec-

tive and least invasive means available to ensure the complete protection and the preservation of the total occlusal from the carious phenomenon (4, 5).

## Features

At present, as a sealant, it can be defined that material which, applied in the pits and fissures of the premolars and the molars, after acid etching of the enamel and subsequent curing, prevents to the microorganisms of bacterial plaque to stagnate, proliferate and affect healthy tissue underneath (5).

The application of the sealing material is able to create a true protective barrier that obstacles the contiguity between the area most susceptible to dental caries and oral microenvironment, thereby eliminating one of the most important etiological factors of the “triad of Keyes”. It is now generally accepted that this power prevention of the sealants depends on the retention in the time of the same material (6).

In 1991, Simonsen developed a randomized trial of two groups of individuals matched for age, gender, residence with remote control of 15 years (7). In the group treated with sealing fissures and pits, the 69% of individuals showed healthy occlusal surfaces after 15 years from the clinic application of the protective resin, while only 31% showed decayed teeth or treated. In the control group, however, 17% of individuals showed healthy occlusal surfaces, and 83% showed decayed teeth or treated (7).

That said, the requirements of a sealant consist in a series of organoleptic, physics-chemical, bio-compatibility, ease of use and affordability that, held them all together, make this material an ideal product (5). In particular, regarding the chemical-physics characteristics, the sealant material must possess a high degree of wettability and a degree of viscosity such as to allow the penetration into microcracks of the etched enamel (5). This property is expressed by “coefficient of penetration”, which is directly proportional to the surface tension of the liquid and indirectly proportional to the viscosity of the material itself (5). It is clear, therefore, that the lower is the vis-

cosity of a sealant, the greater will be its coefficient of penetration and therefore will be greater its retry and its effectiveness (8). At the base of the test more than once, of course, there is the treatment with phosphoric acid to 37% of the enamel surface that greatly increases the potential surface contact for the sealant, creating microspaces tooth structure, allowing strong ties mechanical (8). Other important features are the resistance to the abrasion, which should always manifest values of Knoop hardness between 15 and 20, and the coefficient of polymerization shrinkage, which should be in the order of 4% (for resins based on BIS-GMA) (8).

The aesthetic characteristics, although important, seem to be secondary to preventive goal in the pediatric age. For this reason, colored sealants have been produced over the years, with the aim of making easier the clinical control of their integrity over time (9). In a study carried out on a sample of 31 individuals, aged between 6 and 9 years old, Kargul et al. have compared, in terms of remanence two sealants colored by resin-based, respectively with and without addition of fluoride. Both results are esthetically acceptable and easily visible both in the application, that during the period of follow-up (3 years), allowing a significant protection against the occlusal decay (9).

## Aim of this work

The objective of this work has been to perform a systematic review of the literature, analyzing all the scientific papers published over the past 13 years, covering clinical trials of different sealant resins.

The aim of this research has been to compare the characteristics of each type of material used as a sealant, to highlight the reliability and long-term effectiveness, thus trying to understand which variables could be, both technological and clinics, most important in determining the success of this preventive therapy.

The results of this literature review have been analyzed and subsequently compared with the most recent and important literature reviews concerning the sealing materials (2-4, 10-13).

## Materials and methods

To perform a systematic review of the literature have been chosen initially the basic parameters, the criteria of inclusion and exclusion that each item should have respected in order to be considered proportionate to the objectives of this research. These parameters and criteria have been chosen choosing as a guide the most important reviews of the literature on the subject of oral sealants, published in the last thirteen years (2-4, 10-13).

The searches have been carried out in the MEDLINE database by choosing keywords such as “sealants” and “follow-up”, placing within the limits of the research all the criteria of inclusion and exclusion previously selected. Therefore only studies published in the last thirteen years have been considered in order to have the data as recent as possible and in line with the continuous and rapid progress of dental materials (2). The selected languages have been English and Italian to ensure a proper understanding of the text. Only jobs performed on human beings have been considered, eliminating all those articles relating to animal experiments and only types of scientific articles have been evaluated that fall within the definition of Anglo-Saxon “Clinical Trial” and “Controlled Clinical Trial”, excluding all experimental work *in vitro*, case-reports, meta-

analyzes and literature reviews. This decision has been taken in line with the objectives of this research, for the study and the understanding of the effectiveness of the long-term preventive of oral sealants. Only scientific papers on patients aged between 0 and 18 years have been considered (11). According to the chosen criteria of inclusion and exclusion, all items have been eliminated, particularly those that did not show clinical follow-up of at least 12 months and considered good only clinical trial performed on elements free of caries at the time of the application of the sealant, with at least 2/3 of the surface coronal erupted in the oral cavity, so that the same proves completely visible to the operator and free from mucosal tissues (2, 7, 9-11, 14). There haven't been considered, therefore exclude from this systematic review, the clinical trials which included patients with chronic systemic diseases, patients with physical and mental disabilities and patients who had undergone antibiotic therapy over a period of three months before of the study. There have been also excluded searches that included clinical trials of elements with dental anomalies, hypoplasia of enamel and dentin. There have been used for the present study, only those research projects in which, during the application of the sealant, have followed all the steps suggested by recent clinical literature (Table 1) (2, 3, 10-12).

**Table 1** - Criteria of inclusion and exclusion.

INCLUSION CRITERIA	EXCLUSION CRITERIA
LANGUAGE: ITALIAN AND/OR ENGLISH	OTHER LANGUAGE
LIVE WORK AND ON HUMAN BEINGS	WORK <i>IN VITRO</i> AND/OR ON ANIMALS
PZ HEALTHY AND COLLABORATE	PZ WITH DISABILITIES AND/OR SYSTEMIC DISEASES
AGE BETWEEN 0-18 YEARS	AGE RANGE OVER 18 YEARS
FOLLOW UP TO 12 MONTHS	FOLLOW UP LESS THAN 12 MONTHS
JOBS FROM 1999 TO 2012	JOBS BEFORE 1999
ELEMENTS HEALTHY AND WITH 2/3 OF THE CROWN ERUPTED	DECAYED ELEMENTS AND/OR WITH DENTAL PROBLEMS
STEP APPLICATION RESPECTED	STEP APPLICATION NOT RESPECTED

According to such criteria of research there are resulted available for an initial analysis only 37 items. Of these, four have been rejected because not congruent with the objectives and parameters laid down in the present research.

Subsequently, five other items have been rejected by abstract because they did not respect the criteria chosen of the inclusion. Following a further article has been rejected, after examining the full text, as it did not respect the procedures of application of the sealant material dictated by the EBD. Of the remaining 29 items have been analyzed the full text, taking note of the most important data and results reported by each and organizing a summary table that would put to comparison:

- type of material used;
- follow-up clinical testing;
- number and age of patients;
- type of elements used in the study and the number of sealings made;
- results.

The data collected from the various studies published in the last thirteen years, have been used to perform comparative statistical analysis between the various sealing techniques and to extrapolate general data on the use and effectiveness within 12 months of the sealants (Table 2).

**Table 2** - Comparative statistics analysis between the various sealing techniques.

MATERIALS USED	RB SEALANTS RMGI COMPOMERS
FOLLOW-UP	12 MONTHS
NUMBER OF PATIENTS	1900
AVERAGE AGE	2.5-17 YEARS
NUMBER SEALS	7411
TYPE ELEMENTS	FIRST PERMANENT MOLARS
RESULTS	GREATER VALUE OF RETENTION TO ONE YEAR WITH RB SEALANTS

The purpose of this analysis performed in this systematic review has been to establish some clinical parameters such as:

1. technical reliability of the sealing materials used in dental practice prevention;
2. effectiveness of such materials in the prevention of the pathology of caries in the short (12 months) or long term (several years);
3. need of check and the temporal distance of the same from the date of application of the sealant material;
4. best techniques in the application of these materials.

The data related to each parameter have been then compared with those from the major reviews of the literature performed in the last thirteen years (2-4, 10-13).

## Results

With this revision it has been possible to analyze a total sample of 7411 seals made using resin-based sealants (RB Sealants), modified glass ionomer sealants (RMGI) and sealants compomer. The total number becomes even greater if we consider also sealants as composites flowable and adhesives highly filled. The total number of patients, considering all the 29 studies on which it is based this research, it is of 2900 individuals, with an age range between 2.5 and 17 years. The statistical values of arithmetic and weighted mean obtained in the present work are shown in Table 3.

**Table 3** - Statistical values of arithmetic and weighted mean.

	AVERAGE VALUE OF RETENTION	
	ARITHMETIC AVERAGE	WEIGHTED AVERAGE
<b>RB SEALANTS</b>	69.9%	63.6%
<b>RMGI</b>	31.3%	16.9%
<b>COMPOMERS</b>	44.7%	45.2%

The highest average of total retention to 12 months of sealant on the occlusal surface of the teeth has been obtained with the RB Sealants (69.6% arithmetic mean; 63.6% weighted average); this value has proved much higher than that of retention to 12 months offered by RMGI (Resin Glass Modified Ionomer), which has had the lowest retention values to among all types of sealants used in 27 studies, representing a total or partial loss of the material after one year of applying (31.3%, 16.9%). The Compomers, although used in only two of the 29 studies analyzed, have showed intermediate values of total retention (44.7%, 45.2%). Considering the total retention in a year of the three groups together (which according to the literature can be defined as “conventional”, as the most widely used in both clinical and experimental studies), it stands at values close to 50% (48.5%, 51.6%). It is important to underline that the highest values ever have been detected with the use of RB Sealants after the isolation of the operative field with a rubber dam (77.3%, 81.1%). The use of an adhesive system with a RB Sealants has showed values lower of retention of the RB Sealants used on their own (55.6%, 56.9%). The incidence of caries to 12 months has been proved to be very low for all types of sealants used (2.5%).

## Discussion

The data obtained from this research can help, when compared with those of other systematic reviews in the literature, to understand the variables that may affect the long-term effectiveness of the sealing materials (2-4, 10-13). It is important to underline that this research has assessed as clinical success the total retention of the sealing material to a year, while as clinical failure the partial or the total loss of the material still than to one year from its application. This decision is triggered by the order to establish the average monitoring times required in clinical practice. It is clear, in fact, that a seal with a total or a partial loss of material will require, in clinical

control, a re-operation, which however a seal intact will not require. In this study have been considered both the arithmetic mean values that weighted average values. In the second case, the choice has been determined by the decision to give different weights to different percentages based on the number of samples that each study considered. In agreement with literature reviews conducted by Azarpazhooh et al. in 2008 and Ahovuo-Saloranta et al. in 2008, there have been found higher values of total retention to a year for the group of RB Sealants than RMGI (11, 12). These results are most likely due to the improved properties of adhesion to dental substrates demonstrated by resin-based sealants, able to sneak in a better way in the pits and fissures compared to the modified glass ionomer sealants (2, 12, 14-16). These differences in retention are evident in many of the 29 clinical trials taken as the basis for this review of the literature: Amin, Subramaniam et al., Poulsen et al., Oba et al., have found significant differences ( $p < 0.05$ ) between the total retentions offered by RB Sealants and RMGI (15-18). Another study carried out in 2010 by Baseggio et al. and a report of the American Dental Association Council on Scientific Affairs of March 2008, also recommended the use of RMGI with the elements that are not fully erupted, in which the oral contaminants could affect the stability of adhesion of resin-based sealants, and so the use of the rubber dam couldn't be possible (2, 7, 14, 15).

The Compomers used as sealants have demonstrated a total retention value intermediate between the two classes of sealants described above. These values, however, are not to be considered as absolute because of the few studies that examined these materials (only 2 out of 29 analyzed) (17). RB Sealants, RMGI and Compomers have been considered in this study, “Conventional Sealants” as they are the most used in clinical research carried out in the 29 articles analyzed. Considering therefore the category “Conventional Sealants” as the union of the three groups of materials described, retention values have been obtained in total a year, close to 50% (in particular 48.5% as the arithmetic average and 51.6% as the weighted

average). This is important to understand how, regardless of the material used as a sealant, a year after only a sealing of the two is still perfectly intact and therefore does not need a re-operation. This is important to determine the times of control and recall of young patients that do not exceed 12 months, but which are estimated between 6 and 12 months (7, 15). This consideration is in line with those reported by Azarpazhooch et al. in 2008 (12).

It is also important to underline how critical are the application technique and the isolation of the operative field in the determination of the clinical success of long-term sealing materials. According to the findings reported by other literature reviews, sealants (both RB Sealants that RMGI) used with isolation of the operative field through the rubber dam, have demonstrated retention values to a total year much higher compared to cases in which the isolation of the element had been performed with simple cotton rolls (2, 11, 12, 19). These values in the present work amounted to 77.3% (arithmetic mean) and 81.1% (weighted average). This result is partially disagree with the considerations of Oliveira in 2008 where the positive effects of isolation with a rubber dam are denied, despite of in the study there is a difference of more than 10% in the total retention of a RB Sealants used with this isolation and same sealant used with isolation with cotton rolls (20).

The excellent results of total retention obtained with the application of the sealant under the rubber dam are reported in particular in a study conducted by Corona et al. in 2005 in which very high values of 95% have been reached after 12 months (21).

In a study conducted by Yazici et al., it is analyzed how a technique of preparation of the surface enamel through etching and air abrasion of the tooth, increases the values of total retention to a year RB Sealants (22). There is also a single article that compares, examining as techniques distinct the acid etching and the air abrasion and that does not note a statistically significant difference between the two in terms of retention of the sealant and of future development of caries in the final result (23).

It is important to underline, always talking about the techniques of application of sealants, how the use of an adhesive system (be it Total-Etch or Self-Etch) together with a RB Sealants, does not increase the value of total retention to 12 months, which is around 56%. However, in the study performed by Nogourani et al., it is highlighted as the sealing performed by previous use of adhesive, is less susceptible to cross-contamination from oral fluids (20, 24-27).

Regarding the preventive role of sealants in oral pathology caries, this research is in line with the results of the most recent literature reviews that unanimously agree with the fundamental role that these materials can have in the prevention of this disease in children (2-4, 10-13). In this review of the literature, the data on the incidence of caries at 12 months of sealed teeth are very low, at around 2.5%. There haven't been found significant differences in the incidence of tooth decay among the various sealing materials used. Despite of the lower retention demonstrated by RMGI, these materials have the same protective power for the tooth surface when compared with the RB Sealants. This figure can be explained by the continuous release of fluoride that these materials give and by the permanence of micro particles of material in the pits and fissures (2, 3, 7, 9, 10, 14, 15). Considering the long-term prevention (years) offered by the oral sealants, Bravo et al. brings interesting values: to 9 years, 26.6% of the items sealed has developed caries, restorations or it is either missing in the arch (DMFT index) compared to the value of 76.7% for items that had not undergone seals (28). According to a follow-up of 15-years performed by Jodkowska, the elements sealed had a reduction of caries and restorations of 54% (29). These data are in accord with the literature reviews of reference for this study (2-4, 10-13).

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## Conclusions

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The effectiveness of sealing materials in the prevention of caries disease has been demonstrated over the years (2-4, 10-13). The proper use of

these materials and the respect of each clinical step in their application is the basis of this effectiveness.

In terms of retention, the sealants resin-based (RB Sealants) are the materials that give more guarantees of success to 12 months, while significant differences in the same period haven't been found in caries prevention of disease among the various classes of materials sealants analyzed. The isolation of the operative field through the rubber dam, when it is possible, increases the properties and the effectiveness of the materials in the long term. The use of dental substrate preparation techniques, such as phosphoric acid etching, followed by air abrasion, increases the values of total retention of the sealants used.

Analyzed the probability of total retention to 12 months of conventional sealants (considering with this word all the materials currently used as sealants oral, such as RB Sealants, RMGI and Compomers) which is around 50%, it is necessary to establish clinical controls in a period of time between 6 and 12 months from the application and no later than.

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*Correspondence to:*

Roberta Condò  
Department of Clinical Sciences and Translational Medicine  
University of Rome "Tor Vergata"  
Via Montpellier 1 - 00133 Rome, Italy  
E-mail: roberta.condo@uniroma2.it