

# Clinical Comparison of Flowable Composite to Other Fissure Sealing Materials – A 12 Months Study

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## ABSTRACT

*The subject of the study was the clinical analysis of six different sealing materials over a 12-months period. It was necessary to prove the clinical success of sealing with flowable composite with the use of adhesive system and preventing effect of sealants on caries development. Our study included children aged from 6 to 15, and we sealed 326 teeth with materials from the group of flowable composites in combination with adhesive system (Admira Bond+Admira Flow, Excite+Tetric Flow) and other sealing resins (Teethmate F1, Admira Seal, Helioseal Clear Chroma, Fissurit FX). Over a 12-months period, the total retention was 83.3% (Tetric Flow), 81.5% (Admira Seal), 81.5% (Fissurit FX), 76.4% (Teethmate F1), 75.9% (Helioseal Clear Chroma) and 74.6% (Admira Flow). Only 5 molars (1.5%) developed clinical caries, so fissure sealing has showed to be an excellent prevention of occlusal caries. Flowable composites used with adhesive system are equal to other sealing materials. Sealing materials show great and durable preventive effect against caries development in the fissure system. Since there are many different sealing materials, adhesives, flowable composites on the market and many different pretreatments of the enamel, future studies are necessary and should have an aim to investigate the best technique and material for fissure sealing.*

**Key words:** fissure sealing, caries prevention, flowable composite, adhesive system

## Introduction

Young permanent teeth have specific occlusal morphology with deep and narrow pits and fissures that cannot be adequately cleaned, and therefore present particularly vulnerable places for development of initial caries lesion<sup>1</sup>. Although occlusal surface presents only 12.5% of complete tooth surface<sup>2</sup>, 85% of dental caries occurs on occlusal surface<sup>3</sup>.

Even in countries with well organized prevention and systemic fluoridisation, there are 90% of caries lesions diagnosed on occlusal and bucco-lingual surfaces<sup>4,5</sup>. Although it is suggested that fissure sealing treatment should include only children with moderate caries risk, 90% of children have some form of caries till the age of 18, mainly located on the permanent molars. Therefore all children should be included in the fissure sealing treatment during the period of permanent teeth eruption<sup>6</sup>.

Saving healthy and intact tooth structure is of major importance in modern dentistry. When cavitation appears it requires lifelasting checkups because there is no dental material that is everlasting. Fissure sealing treatment should be planned according to the individual needs of a patient and should include modern diagnostic techniques such as: laser fluorescence, electrical conductance measurement, microabrasion and X-rays<sup>7</sup>, before fissure sealing.

Placed fissure sealing material has to be controlled periodically and restored if any failure is present. According to the American Academy of Pedodontics, fissure sealing materials should be placed according to the valid standards, taking into consideration following criteria: previous dental caries, oral hygiene, patient's age, specific occlusal morphology, and time the tooth has been exposed to oral microflora. Modern sealing resins placed by

trained professionals are safe and effective way of preventing fissure caries. The efficiency grows with good technique and appropriate recall period, which includes reapplication of the sealing material, if necessary. The risk for caries development persists on every tooth with pits and fissures and is not related with the patient's age. It is confirmed that glass-ionomer resins are not effective in preventing caries when used as sealing materials, so they should be used only as a temporary sealing material<sup>8</sup>.

With fissure sealing, fissures and pits are sealed and closed by a material which is retained to the enamel by acid-etching technique or chemical bonding technique. Since this procedure was presented in the late 1960's, based on resins and acid-etching, during its existence many different methods of prevention, interception and restoration of caries of pits and fissures have been developed<sup>9</sup>.

Sealing materials present very effective mechanical barrier for the entrance of plaque into the fissure, which reduces the impact of cariogenic microorganisms on the enamel surface to the smallest extent.

Preventive benefit from the fissure sealing treatment is based on an ability of sealing materials to close pits and fissures and other morphological irregularities completely, and to stay intact and adherent to enamel surface during a long period of time. A partial loss of material in a sealant causes microleakage which leads to caries development under the sealing material<sup>10–14</sup>.

Today there is a wide choice of different sealing materials used clinically, from glass-ionomer cements<sup>15–20</sup>, composites<sup>21–24</sup>, sealing resins<sup>25–30</sup>, adhesives<sup>31,32</sup> to flowable composites<sup>33–37</sup>.

The aim of this study is to evaluate the retention rate of flowable composite used as a fissure sealant, compared to the other sealing materials, over a 12-months period.

## Materials and Methods

The study includes 6 different materials, used as sealants on 326 permanent molars at children aged between 6 and 15. Fissure sealing treatment has been carried out on 130 children, and each child had at least 2 permanent molars sealed with 2 different materials. The study has been carried out at The Department of Pediatric Dentistry, School of Dental Medicine in Zagreb. Sealing materials have been placed by dentists and by senior students. Subjects were randomly selected according to the plan of regular checkups and therapy. The criteria for teeth selection for the fissure sealing treatment were healthy permanent molars that did not show any sign of caries development after a standard examination using dental probe and dental mirror by standard dental illumination. Molars that have not erupted completely and were partially covered by operculum, were excluded because of the possible complications, such as contamination of a dry working field. Fissure sealing is a standard treatment in pediatric dentistry, and is well known to

children and their parents, so the written consent from the parents for the whole procedure was obtained.

Materials used as sealants:

Helioseal Clear Chroma (Vivadent, Schaan, Liechtenstein), light-cured low-viscosity unfilled sealing material with reversible colour change.

Teethmate F1 (Kuraray, Kurashiki, Japan), light-cured low-viscosity unfilled sealing material with fluoride release.

Tetric Flow (Vivadent, Schaan, Liechtenstein), light-cured flowable composite (68.1% of weight) for wide use in restoration dentistry and for fissure sealing, used in combination with adhesive system Excite (Vivadent, Schaan, Liechtenstein).

Admira Seal (Voco, Cuxhaven, Germany), light-cured Ormocer-based, low-viscosity filled (54% of weight) fissure sealant.

Fissurit FX (Voco, Cuxhaven, Germany), light-cured low-viscosity filled (55% of weight) sealing material with fluoride release.

Admira Flow (Voco, Cuxhaven, Germany), light-cured flowable Ormocer-based composite (63 % of weight) for wide use in restoration dentistry and for fissure sealing, used in combination with adhesive system Admira Bond (Voco, Cuxhaven, Germany).

The procedures, how materials were used for sealing, are presented in Table 1.

All materials were polymerized by 3M ESPE Elipar LED polymerization lamp according to manufacturer's instructions. It is important to stress out that all sealants were checked up after polymerization for eventual defects such as air inclusions or other failures. The eventual defects were immediately eliminated by reapplication of a material in still dry field so that possibility of irregularities was brought to a minimum.

Regular inspection was carried out after 12-months, always by the first author in the study. The inspection included dental probe and dental mirror under standard illumination.

Evaluation of sealants was based on the modified criteria described by Pardi et al<sup>22</sup>:

- Total Retention (TR): total retention of sealing material
- Partial Retention 1 (PR1): loss of 2/3 of sealing material
- Partial Retention 2 (PR2): loss of 2/3 of sealing material
- Total Loss (TL): total loss of sealing material

Criteria of caries evaluation:

- No visible caries (–)
- Caries present (+)

The teeth with loss of 1/3 or 2/3 of sealing material and without visible caries lesion underwent reapplication of the same sealing material after 12 months, including pretreatment of the enamel, which depended on the material that was used. If caries was present, minimal invasive treatment was carried out.

**TABLE 1**  
COMPOSITION OF MATERIALS AND THEIR CLINICAL USAGE

Material	Batch No.	Composition	Clinical Use
Helioseal Clear Chroma	E50431	Bis-GMA, triethylene glycol dimethacrylate (99% weight), catalysts, stabilizers and pigments (1%).	Cleaning with nylon bristle brush and non-fluoridated paste, etching with 37% orthophosphoric acid for 40 s, rinsing with water 40s, drying with air 20s, isolating with cotton rolls and saliva ejector, sealant application with product's cannulae, waiting for penetration 10s, polymerization for 40s, check for discontinuity and occlusion.
Teethmate F1	0059A	Adhesive monomer MDP (10-Methacryloyloxydecyl dihydrogen phosphate), fluoride, less than 10% inorganic fillers.	
Admira Seal	381936	ORMOCER®, aromatic and aliphatic dimethacrylates, BHT, 54% inorganic filler (glass-ceramic 0.7μ), fluoride.	
Fissurit FX	391107	Methacrylic acid, inorganic filler(glass-ceramic 92% weight, glass-ionomer 8% weight, fluoride 1%(2% NaF)).	
Excite	C 09404	HEMA,dimethacrylates, phosphoric acid acrylate, silicon dioxide,stabilizers, alcohol.	Cleaning with nylon bristle brush and non-fluoridated paste, etching with 37% orthophosphoric acid for 40 s, rinsing with water 40s, drying with air 20s, isolating with cotton rolls and saliva ejector, applying bond with brush for 10s, drying with gentle air 2s, polymerization 10s.
Admira Bond	550439	ORMOCER®, aromatic and aliphatic dimethacrylates BIS-GMA, HEMA, BHT, acetone, organic acids.	Application with product's cannulae, waiting for penetration 10s, polymerization for 40s, check for discontinuity and occlusion.
Tetric Flow	0303001477	Bis-GMA, UDMA,triethilene glycol dimethacrylate, inorganic filler 67.8% by weight (barium glass, ytterbium trifluoride,silicone dioxide, fluorosilicate glass).	
Admira Flow	500859	3 Dimensional anorganic-orcanic co-polymers (ORMOCERS®), aromatic and aliphatic dimethacrylates, 64% anorganic filler (by weight).	

**TABLE 2**  
PERCENTAGE OF RETENTION RATE AND CARIES OF 6 SEALING MATERIALS AFTER 12 MONTHS

Retention rate	Teethmate F1		Helioseal Clear Chroma		Tetric Flow		Admira Seal		Fissurit FX		Admira Flow		Total	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
TR	42	76.4	41	75.9	45	83.3	45	81.5	44	81.5	41	74.6	257	78.8
PR1	11	20.0	8	14.8	9	16.7	9	16.7	9	16.7	12	21.8	54	16.6
PR2	1	1.8	3	5.6	0	0	0	0	1	1.9	2	3.6	10	3.1
TL	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Caries	1	1.8	2	3.7	0	0	2	3.7	0	0	0	0	5	1.5
Total	55	100	54	100	54	100	54	100	54	100	55	100	326	100

TR – total retention, PR1 – partial retention 1, PR2 – partial retention 2, TL – total loss

## Results

Over a period of 12-months, total retention rate (TR) in the fissure was from 74.5% to 83.3% (Table 2). It can be concluded that the annual loss of sealing material is from 16.7% to 25.5%. The loss of 1/3 of sealing material (PR1) is from 14.8% to 21.8%. All materials show high rate of retention during a period of 12 months, which confirms that there is no total loss of any material (TL). Tetric Flow, Admira Seal and Fissurit FX show the best results in retention rate. However, according to the results of chi-square test there are no statistically signifi-

cant differences between these sealing materials ( $\chi^2=13,891$ ,  $df=15$ ,  $p=0,534$ ).

The incidence of caries is 1.8% for Teethmate F1, 3.7% for Helioseal Clear Chroma and 3.7% for Admira Seal. Other materials have not shown any signs of caries development. The results of chi-square test show that distribution of sealing materials does not depend on tooth position in the dental arch. Moreover, there is no statistical difference in sealant retention between first or second molar. According to this study, for sealing of the first permanent molar an average age was 9.58, and 12.6 years for sealing of the second permanent molar.

## Discussion

The aim of this study was to evaluate differences of the clinically retention rate among different dental materials used as fissure sealants. The usefulness of flowable composites as fissure sealants in combination with adhesive system has also been evaluated.

Traditional fissure treatment before sealing, which includes brushing with water-pumice and prophylactic paste for cleaning the fissures from dental plaque, is not efficient enough in preventing microleakage, so some experts suggest enameloplasty with steel or diamond burr providing deeper penetration of sealing material. Although studies show better results when using enameloplasty and acid-etching technique<sup>38,39</sup>, there is no statistically significant difference between traditional pretreatment of fissures and enameloplasty<sup>40–43</sup>. Some studies have shown better retention rate of sealing materials when laser therapy had been used before sealing<sup>44</sup>. However, other studies have shown that there is no statistically significant difference between laser therapy and other techniques<sup>45–47</sup>. It is considered that the traditional pretreatment including brushing with prophylactic paste and acid-etching is a standard procedure before sealing<sup>43,48</sup>.

The use of flowable composite as fissure sealant is new in dentistry. The results of some studies have shown lower retention rate of flowable composite compared to the retention rate of resins, which is probably caused by not applying the adhesive system which surely improves the adhesion of flowable composite to the enamel<sup>33</sup>. The high retention rate of flowable composite when used with adhesive system has been confirmed<sup>34, 36,37,49</sup>.

Our study shows that the retention rate of flowable composite with acid-etching and adhesive system is 83.3% for Excite+Tetric Flow over a 12-months period, and 74.5% for Admira Bond+Admira Flow. Some similar studies have shown the total retention rate of 100% for flowable composite Flow-It! over a 12-months period<sup>34</sup>.

Over a 24-months period there are statistically significant differences in retention rate between flowable composites and other sealing materials<sup>49</sup>. Autio-Gold<sup>33</sup> shows very low retention rate of flowable composite, which has been 56.3% over a 6-months period and 40% over a 12-months period, and show that they are no better than resins. Perhaps this is because no adhesive system has been used before the sealant placement, and the author suggests its use in the future studies. Furthermore, laboratory studies show great ability of flowable composite to penetrate deeper into the fissure system<sup>50,51</sup>. Other studies also confirm great physical and mechanical characteristics of flowable composite<sup>49,52,53</sup>.

Some authors suggest use of the adhesive system after acid-etching and before placement of the flowable composite providing better marginal adaptation and retention rate of flowable composite<sup>18,36,53</sup>.

Self-etched adhesive systems should not be used as pretreatment of the enamel because of their low adhesive strength, high rate of microleakage and its insufficient

etching ability<sup>54–56</sup>. Enamel in the fissure system is resistant to etching due to its anatomical and chemical characteristics. The resistancy is not connected with the changes after the teeth eruption, but with the complicated system of prismless enamel around the entrance and in the walls of fissures. Such prismless crystals show dense and irregular form and are much more resistant to etching and lead to low porosity, resulting in short resin tags<sup>57,58</sup>. Furthermore, self-etched adhesive system is not strong enough to decalcify prisms in enamel resulting in thin lamina-like resin extensions and low quality of adhesion. Low quality of etching may be the result of inactivation of acid in the self-etched adhesive system when it is in contact with enamel causing lower decalcification of enamel<sup>59</sup>. It has been confirmed that self-etched adhesives do not penetrate enough into the enamel but are limited only to prismless enamel<sup>60</sup>.

The results of the Celiberti et al.<sup>61</sup> study show that microleakage does not always have to be in correlation with resin tags. Resin tags show only the depth of etching and do not mean clinical success. Deeper etching of the enamel could provide better penetration of the sealing material, but does not guarantee great adhesion between sealing material and enamel, free from microleakage, and with better retention rate. A 24-months long clinical study has shown that there is no difference between self-etched adhesive system and adhesive system requiring etching<sup>62</sup>.

The total retention of the sealing resins in our study is 76.4% for Teethmate F1 and 83.3% for Tetric Flow over a 12-months period. The results are similar to the results of other studies that have shown the retention rate of 77% for Fluoroshield<sup>29</sup>, and 86.1% for Delton FS+ over a 12-months period<sup>63</sup>.

Other studies show very high retention rate of sealing materials, so Vrbič<sup>28</sup> shows total retention rate for Helioclear F of 98% after 12 months, and Corona et al.<sup>34</sup> show retention of 100% for Flow-It! and 95% for Fluoroshield after 12 months.

Also, the retention rate of Helioclear has been 100% on upper molars, and 97% on lower molars after 12 months, and 79% and 97% after 24 months of clinical use<sup>64</sup>.

Some studies have shown low retention rate. Autio-Gold<sup>33</sup> has confirmed the rate of 64% for Delton after 18 months, and CuRay-Match the rate of 40%. Yildiz et al.<sup>25</sup> have shown the retention rate of 57.4% and 45.9% for Concise Light Cure White sealant and Helioclear F after 12 months. In the study of Puppini-Rontani et al.<sup>65</sup> the retention rate was 43% for Fluoroshield after 12 months.

Our study is in correlation with the study of Pardi et al.<sup>37</sup> where the retention rate of flowable composite Revolution was 76.3% over a 12-months period. In this study adhesive system was also used before sealant placement.

It is important to notice that there are no two completely identical clinical studies so all of the results should be considered with precaution. In clinical work with sealing materials there are more parameters that influence the final results such as; the enamel pretreat-

ment, selection of a person with places sealants and its clinical experience, the way of tooth isolation, the age of a patient and sealing conditions, the time of etching and concentration of acid, the use of adhesives, the choice of material and its physical and chemical characteristics, the way of material application, the way and time of polymerization, and variety of criteria for clinical evaluation of dental materials. Very important phase at fissure sealing is maintenance of a dry working field to prevent contamination with saliva and other fluids.

With this study we have proved preventive effect of all sealing materials, because there have been only 5 molars (1.5%) of all 326 sealed molars with developed caries in fissure system. No sealing material shows total loss (TL) of material, so it can be confirmed that modern materials and adhesives have improved physical and mechanical characteristics. Similar studies show low rate of clinical caries occurred in fissures after sealing; 0.9% for resin modified glass-ionomer Vitremer, 2.8% for flowable composite Revolution and 2.7% for flowable compomer Dyract Flow, after 12 months<sup>37</sup>.

In the study of Rajić et al.<sup>64</sup> there were no caries detected in the sealed fissures after a 12 months of clinical

use. The same results are present in the study of Puppini-Rontani et al.<sup>65</sup> after 24 months.

DMFT index was 3.5 in the group of 12 years old children in Croatia in 1999. It is a moderate rate of caries prevalence and can be even lower with the use of modern sealing materials, fluoridization, control of eating habits (sugar consumption) and optimal oral hygiene<sup>66</sup>.

## Conclusion

1. Flowable composites show great clinical qualities and are valuable in clinical work as fissure sealing material same as sealing resins. However, further studies are necessary in order to evaluate its superiority to other materials in clinical work.
2. All sealing materials show great and durable preventive effect against caries development in the fissure system.
3. Since there are many different sealing materials on the market, adhesives, flowable composites and many different pretreatments of the enamel, future studies are necessary and should have an aim to investigate the best technique and material for the fissure sealing.

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## **USPOREDBA TEKUĆEG KOMPOZITA I OSTALIH MATERIJALA ZA PEČAĆENJE KROZ KLINIČKI PERIOD OD 12 MJESECI**

### **S A Ž E T A K**

Svrha ovog rada je klinička analiza 6 različitih materijala za pečaćenje kroz period od 12 mjeseci. Također, potrebno je dokazati klinički uspjeh pečaćenja fisura zubi s tekućim kompozitom uz uporabu adhezivnog susutava, te preventivni učinak pečatnog materijala na razvoj karijesa fisura. U našem radu smo pečatili 326 zubi kod djece u dobi od 6 do 15 godina i to materijalima iz skupine tekućih kompozita koji su se koristili s adhezivnim susutavom (Admira Bond+ Admira Flow, Excite+Tetric Flow), te ostalim smolama za pečaćenje (Teethmate F1, Admira Seal, Helioseal Clear Chroma, Fissurit FX). Nakon 12 mjeseci, potpuna retencija materijala iznosi 83.3% (Tetric Flow), 81.5% (Admira Seal), 81.5% (Fissurit FX), 76.4% (Teethmate F1), 75.9% (Helioseal Clear Chroma) i 74.5% (Admira Flow). Samo 5 molara (1.5%) od 326 zapečaćenih zubi je razvilo karijes te se pečaćenje fisura pokazalo kao odličan postupak za prevenciju karijesa okluzalne plohe. Materijali iz skupine tekućih kompozita u kombinaciji s adhezivnim sustavom su istovrsni i ravnopravni ostalim materijalima za pečaćenje fisura. Pošto na tržištu postoji mnogo različitih materijala za pečaćenje, adheziva, tekućih kompozita i različitih predtretmana cakline, potrebna su daljnja istraživanja kako bi se pronašla najbolja tehnika i najbolji materijal za pečaćenje fisura.