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Flowable composite as fissure sealing material? A systematic review and meta-analysis

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In brief

Suggests flowable composite may be used as fissure sealant material.

Shows the success rate of flowable composite as fissure sealant material is superior to traditional fissure sealants.

Indicates that the use of flowable composites as a fissure sealing material had slightly positive effect on the retention rate compared with conventional sealants.

Objectives The aim of this systematic review and meta-analysis was to evaluate fissure sealant retention in clinical studies in which investigators used flowable composites as pit and fissure sealants compared with conventional resin-based pit and fissure sealants. **Data sources and data selection** The authors conducted a literature search (all articles published until April 13, 2017) to identify studies for inclusion in this systematic review. They assessed the quality of the evidence provided by using the modified Jadad scale and performed meta-analyses by using a random-effects model. **Data extraction and data synthesis** The authors found 11 studies that met the inclusion criteria for the systematic review and nine studies that could be used for the meta-analysis. Of the 11 studies identified in the systematic review, four scored as having a low risk of bias, and seven scored as having a medium risk of bias. Our meta-analysis showed a significant positive effect of using flowable composites as a fissure sealant material (odds ratio, 2.387 [95% CI, 1.047, 5.444; P = 0.039]). **Conclusion** It seems that the use of flowable composite as a fissure sealing material can slightly increase the retention rate of sealants compared with conventional resin-based sealants.

Introduction

Dental caries is one of the most prevalent diseases worldwide. Although only 12.5% of all tooth surfaces are occlusal, these complex morphological surfaces develop more than two-thirds of the total caries experience of children owing to their susceptibility to plaque accumulation and food retention. Despite the increased scientific knowledge of dental caries, improved oral hygiene, the widespread use of fluoride in recent decades and the remarkable decline of caries prevalence, these factors have been less effective in caries reduction on occlusal surfaces.[1–4]

In adjunct to these procedures, pit and fissure sealant therapy as an ultraconservative procedure was introduced in the 1960s to protect pits and fissures on the occlusal tooth surfaces from dental caries. The sealing material acts as an effective mechanical barrier to plaque retention, thereby minimising the harmful effect of cariogenic microorganisms on the enamel surface.[5–11] Some reviews and meta-analyses and a 2016 guideline by American Dental Association that is also based on a systematic review, showed that pit and fissure sealants are effective in preventing the initiation of caries in sound, susceptible pits and fissures in children and adolescents, particularly when used with an adhesive system on a conservatively prepared surface.[12–15] Investigators in ongoing studies are assessing the retention of sealants after the application of different sealant materials and techniques. Currently, many varieties of sealing materials are used clinically from glass ionomer cements, compomers, and conventional resin-based fissure sealants to flowable composites. The most widely used fissure sealants are based on bisphenol A-glycidyl methacrylate (BisGMA) resins or urethane-based products.[16,17]

Flowable resin composite was first introduced by Ibsen (1972) for use in restoring cervical erosion and has found many applications in dentistry, such as stress-relieving gingival increments in Class II and V restorations.[18–20]

Over the past 15 years, these materials have been further developed, and the applicability of flowable composites as pit and fissure sealants has expanded because of their desirable properties, such as low viscosity, low modulus of elasticity, and ease of handling. It has been proposed that a greater quantity of filler particles may lower the porosity and cause less polymerisation shrinkage with better wear resistance, which is particularly important when the material used is of low thickness relative to conventional resin-based pit and fissure sealants.[21–25]

Research question

The aim of this systematic review and meta-analysis was to evaluate the fissure sealant retention in clinical studies in which investigators used flowable composites as pit and fissure sealants compared with conventional resin-based pit and fissure sealants.

Methods

Eligibility criteria, information sources and search strategy

Based on the PRISMA guidelines,[26] we defined the PICOS (participants, intervention, comparison, outcomes and study) analysis (Table 1), and studies were reviewed.

The following sources have been searched for the publications: PubMed, SCOPUS. Embase,

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Cochrane Database of Systematic Reviews (via Wiley Online Library), ISI Web of Knowledge (All Database: Web of Science Core Collection, Current Contents Connect, Data Citation Index, Derwent Innovations Index, KCI Korean Journal Database, MEDLINE, Russian Science Citation Index, SciELO Citation Index). These sources are commonly used to define search strategies in the field of dentistry and other medical disciplines.[27–29]

We used a combination of controlled vocabulary and free-text for PubMed (Box 1). For other sources, the same appropriate search strategies were designed. Our final search was performed on April 13, 2017. There were neither time nor language restrictions for eligibility for inclusion. If we required more clarification, we contacted the authors via email.

Inclusion and exclusion criteria

For the systematic review, we included clinical studies evaluating a flowable resin composite as a fissure sealant material on permanent teeth. Those studies must have included a control group with fissure sealant material.

For the meta-analysis, only randomised designed studies that had at least 12 months of follow-up duration were selected.

Furthermore, the following types of articles were excluded from meta-analysis: non-clinical, non-randomised or non-controlled trials or studies with inadequate data for analysis.

Data extraction and outcome measure

One professor (A. S. S.) and one associate professor (A. B.) in the field of paediatric dentistry evaluated the studies independently and selected the relevant articles on the basis of the inclusion criteria.

Any disagreement was debated in a consensus session, and if necessary, a third person from the same department was involved in the decision.

All articles were imported into an EndNote Library (EndNote X7, Thomson Reuters), and duplicate studies were discarded.

We assessed the risk of bias of studies on the basis of the modified Jadad scale,[30] which uses the following questions:

1. Does the study ask a clearly focused question? (Yes/No)
2. Was a randomised controlled trial (RCT) used?
3. Was the method of randomisation appropriate?
4. Was the study described as blind or masked?
5. Was there a clear description of the inclusion and exclusion criteria?
6. Was there a description of any subject withdrawals and dropouts?
7. Was the method used to assess success or failure described?
8. Was the sample size justified (for example, power calculation)?
9. Was the method used in statistical analysis described?

Based on the information in the full-text studies, each parameter was scored as 'Y' (yes) if the parameter was explained on the text, or as 'N' (no) if the authors did not mention that parameter. Any study that earned 7–9 'Y' was rated as having a low risk of bias, 4–6 'Y' was scored as medium and 1–3 'Y' was rated as having a high risk of bias. For the meta-analysis, we used only studies with a low or medium risk of bias.

Assessment of outcomes and heterogeneity

The outcome of the meta-analysis was to determine the retention rate of flowable composite resins used as fissure sealant material and to compare that rate to that obtained for the conventional fissure sealant material. We used the odds ratio and risk difference with 95% confidence intervals (CI) as the main effect size.

The Cochran's Q test, I squared and Tau squared were used to calculate heterogeneity. If the level of heterogeneity was acceptable ($P > 0.10$, or $P \leq 0.10$ but $I^2 \leq 50\%$), a fixed effects model was conducted, however, if we found significant heterogeneity ($P \leq 0.10$, $I^2 > 50\%$), a random effects model was used for the meta-analysis.[31,32]

Comprehensive meta-analysis software (Version 2, Biostat) was used for statistical analyses.

Assessment of publication bias

Based on the recommendations from the *Cochrane Handbook for Systematic Reviews of Intervention*,[33] if we found more than ten studies to be included in the meta-analysis, then we will explore publication bias by using funnel plots.

Results

The PRISMA flow diagram is shown in Figure 1. From all sources, we initially included 510 studies; however, after removing duplicates and discarding irrelevant articles, 11 studies fulfilled our inclusion/exclusion criteria.

Box 1 Main search term for Pubmed

("Pit and Fissure Sealants"[Mesh] OR (Fissure Sealants, Pit) OR (Sealants, Dental) OR (Dental Sealants) OR (Sealants, Tooth) OR (Tooth Sealants) OR (Fissure Sealant)) AND (("natural flow composite resin" [Supplementary Concept] OR "flowable hybrid composite" [Supplementary Concept] OR "Venus flow composite resin" [Supplementary Concept] OR "Charmfil Flow" [Supplementary Concept] OR "Denfil Flow" [Supplementary Concept] OR "tetric flow composite resin" [Supplementary Concept]) OR (Flowable Composite) OR (Low-viscosity Composite) OR (Flow Composite))

Table 1 Search strategy using PICOS analysis

	Definition	Main search terms for Pubmed (Controlled vocabulary and free text terms)
Participants	All teeth with fissure sealant preventative treatment	("Pit and Fissure Sealants"[Mesh] OR (Fissure Sealants, Pit) OR (Sealants, Dental) OR (Dental Sealants) OR (Sealants, Tooth) OR (Tooth Sealants) OR (Fissure Sealant))
Intervention	All teeth with fissure sealant preventative treatment	
Comparisons	Flowable resin composites	("natural flow composite resin" [Supplementary Concept] OR "flowable hybrid composite" [Supplementary Concept] OR "Venus flow composite resin" [Supplementary Concept] OR "Charmfil Flow" [Supplementary Concept] OR "Denfil Flow" [Supplementary Concept] OR "tetric flow composite resin" [Supplementary Concept]) OR (Flowable Composite) OR (Low-viscosity Composite) OR (Flow Composite))
Outcomes	Not applicable	Not applicable
Study design	All included	Search results manually screened to include randomised controlled clinical trials.

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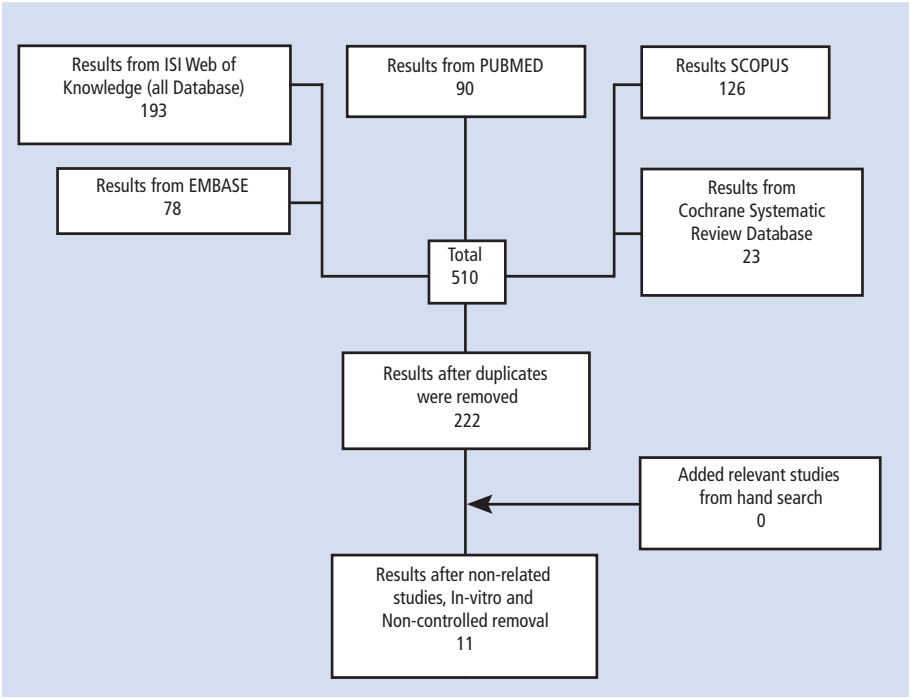
Fig 1 PRISMA flowchart diagram of included studies based on our search strategy



Of those, two studies (Dukic *et al.*)[17,34] could not be used for further meta-analysis due to their non-randomised nature and design. However, two studies (Mathur *et al.* and Oba *et al.*)[35,36] compared one fissure sealant with two flowable composites, and one study (Kucukyilmaz and Savas)[24] compared two fissure sealants with one flowable composite. Thus, from these three studies, we imported two sets of data to our meta-analysis.

Risk of bias

Of the 11 studies included in the systematic review, four scored as having a low risk of bias,[23,24,37,38] and seven scored as having a medium risk of bias[16,17,21,22,34–36] (Table 2). Thus, these studies could all potentially be used for the meta-analysis.

The parameters that most commonly received 'N' were power calculation, appropriate randomisation and blindness.

Descriptive analysis and meta-analysis

Supplementary Table 1 (online only) shows the detailed information of all studies included in the systematic review.

Due to the considerable heterogeneity among the studies (Cochrane Q-value = 51.185, P-value<0.001, I^2 = 78.509), we tried to use a random-effects model to pool the data.

The results of meta-analysis demonstrated that the odds ratio was 2.387 (95% CI, 1.047, 5.444; P = 0.039) (Fig. 2) and the risk difference was 0.093 (95% CI, 0.004, 0.182; P = 0.041) (Fig. 3). As Figure 2 shows, the use of a flowable composite had a positive effect on the fissure sealant retention rate.

Discussion

To improve the quality of this systematic review and meta-analysis, we included only clinical trials for systematic reviews and randomised clinical trials for the meta-analysis of the study. Conventional resin-based sealants, flowable composites, and compomer and glass ionomer (chemical or light-cured) cements were the main sealant materials investigators used in the studies.[6,16,17,23,39]

It is obvious that prevention of caries occurrence is the main goal of the fissure sealant treatment, but determination of the 'complete sealant retention rate' is a more easy and applicable outcome and has been used in most of the studies in this field. Mickenautsch study has

Table 2 Quality assessment of the included studies (Y: Yes, N: No)

First author [Ref]	Clearly-focused question	Randomised controlled trial	Appropriate randomisation	Blindness	Description of the inclusion & exclusion criteria	Description of dropouts	Description of success or failure	Power calculation	Description of statistical analysis	Risk of Bias
Kucukyilmaz[24]*	Y	Y	Y	Y	Y	Y	Y	N	Y	Low
Erdemir[37]*	Y	Y	Y	Y	Y	Y	Y	N	Y	Low
Mathur[35]*	Y	Y	N	N	Y	Y	Y	N	Y	Med
Oba[36]*	Y	Y	N	N	Y	Y	Y	N	Y	Med
Jafarzadeh[23]*	Y	Y	N	Y	Y	Y	Y	N	Y	Low
Cogo[38]*	Y	Y	N	Y	Y	Y	Y	N	Y	Low
Amin[16]*	Y	Y	N	N	Y	Y	Y	N	Y	Med
Dukic&Glavina[34]	Y	N	N	N	Y	Y	Y	N	Y	Med
Dukic& Dukic[17]	Y	N	N	N	Y	Y	Y	N	Y	Med
Corona[22]*	Y	Y	N	N	Y	Y	Y	N	Y	Med
Autio-Gold[21]*	Y	Y	N	N	Y	Y	Y	N	Y	Med

*included in meta-analysis

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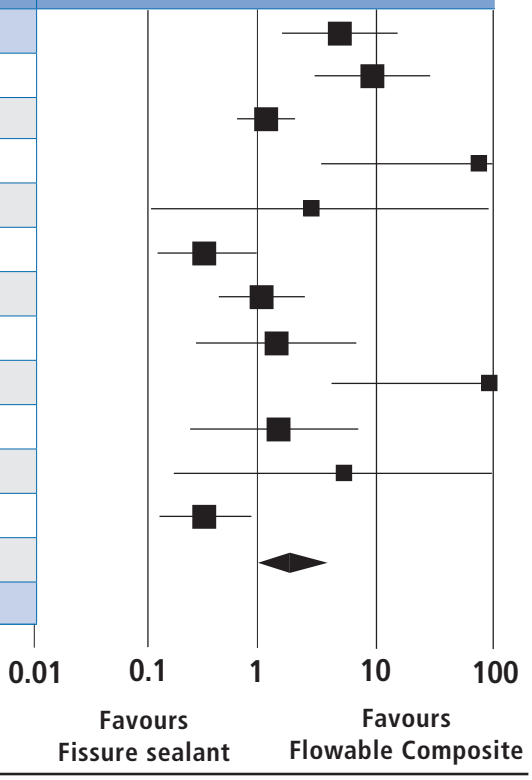
Fig. 2 Meta analysis

Study name	Statistics for each study					Odds ratio and 95% CI
	Odds Ratio	Lower limit	Upper limit	Z-Value	p-Value	
Kucukyilmaz 1	5.357	1.920	14.946	3.206	0.001	
Kucukyilmaz 2	8.190	3.001	22.350	4.105	0.000	
Erdemir	1.316	0.565	3.063	0.636	0.525	
Mathur 1	73.465	4.227	1276.955	2.949	0.003	
Mathur 2	3.076	0.122	77.796	0.682	0.495	
Oba 1	0.359	0.126	1.024	-1.915	0.055	
Oba 2	1.151	0.453	2.926	0.295	0.768	
Jafarzadeh	1.585	0.411	6.114	0.669	0.503	
Cogo	96.873	5.835	1608.294	3.190	0.001	
Amin	1.536	0.365	6.458	0.585	0.558	
Corona	5.260	0.245	113.106	1.060	0.289	
Autio-Gold	0.369	0.157	0.865	-2.293	0.022	
Total	**2.387**	**1.047**	**5.444**	**2.069**	**0.039**	



Heterogeneity:

Cochrane Q-value = 51.185 P-value = 0.000 I-squared = 78.509 Tau-squared = 1446

also showed that 'the risk of loss of complete retention of sealant materials was associated with the risk of caries occurrence for resins.'[40]

The aim of this systematic review and meta-analysis was to determine the complete retention rate of flowable composites as fissure sealants.

The results of the meta-analysis indicated that using flowable composite as fissure sealants had a slightly significant positive effect on retention rates compared with the use of conventional resin-based sealants.

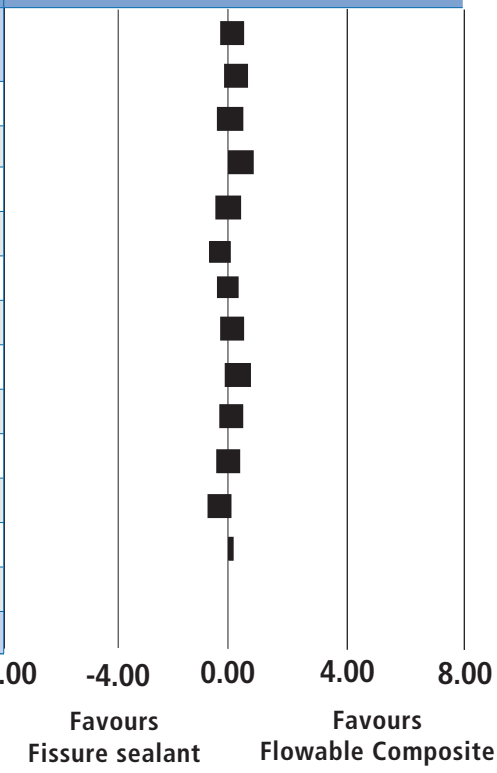
In the 2015 study by Kucukyilmaz and Savas, the results of a 24-month evaluation indicated that flowable composite used with an adhesive system was superior to conventional resin-based sealants.[24] One of the disadvantages of this study was that it used an adhesive system in the flowable composite group alone and not in the conventional resin-based sealants. Since Bagherian *et al.* showed that an adhesive system under resin-based sealants can increase the retention of sealants,[13] this could have been a confounding variable that affected the results of Kucukyilmaz's study.[24] However, in 2012, Mathur and colleagues showed that even without the use of an adhesive system, the conventional and high-filled flowable composite resin, when used as a sealing material, had better retention than unfilled resin sealant in their one-year follow-up duration.[35] In 2009, Cogo and Claura used an adhesive system for both conventional resin-based sealants and flowable composite groups in their 24-month evaluation and showed the better performance of flowable composites than conventional resin-based sealants.[38] In 2014, Erdemir and colleagues (adhesive system only in the flowable composite group),[37] in 2010, Jafarzadeh and colleagues (adhesive system in both groups),[23] and in 2008, Amin (adhesive system in none of the groups)[16] all found that the use of flowable composites as fissure sealant materials yielded slightly better retention than the conventional resin-based fissure sealant. The better retention rates of flowable composite compared with a conventional sealant can be explained because the higher filler content of this material causes less polymerisation shrinkage and consequently decreases the chance of microleakage, which deteriorates the retention. Another explanation is that the higher filler contents of flowable composites may also increase the wear resistance of sealant material and decrease the chance of partial or total sealant loss.

Also, in-vitro studies indicated better physical characteristics of flowable composites compared to conventional resin-based sealants and it seems that the higher viscosity of flowable composites do not have any significant negative effect on their penetration and retention.[41,42]

Oba and colleagues,[36] in 2012, and Autio-Gold[21] in 2002 showed the slightly better performance of unfilled resin sealants compared with flowable composites, but these differences were not statistically significant. Oba explained that the greater fluidity of conventional sealants may cause better penetration into the depths of fissures and consequently a better retentive form of sealants. Some studies, like Autio-Gold's study[21] and others in the 1980s and 1990s[43,44] have shown a better performance of unfilled sealants than filled sealants. This may explain why the earlier generation of filled sealants and flowable composites did not have the ideal resin-filler silanisation to lead to easy filler removal from the surface of sealants and may have caused more plaque accumulation on rough sealed surfaces and margins.

Fig. 3 Meta analysis

Study name	Statistics for each study							Risk difference and 95% CI
	Risk difference	Standard error	Variance	Lower limit	Upper limit	Z-value	p-Value	
Kucukyilmaz 1	0.151	0.042	0.002	0.069	0.233	3.596	0.000	
Kucukyilmaz 2	0.226	0.046	0.002	0.136	0.316	4.905	0.000	
Erdemir	0.031	0.049	0.002	-0.064	0.126	0.638	0.523	
Mathur 1	0.475	0.080	0.006	0.318	0.632	5.948	0.000	
Mathur 2	0.025	0.034	0.001	-0.042	0.092	0.736	0.462	
Oba 1	-0.025	0.102	0.010	-0.405	-0.005	-2.006	0.045	
Oba 2	0.034	0.115	0.013	-0.192	0.260	0.295	0.768	
Jafarzadeh	0.051	0.076	0.006	-0.097	0.199	0.675	0.500	
Cogo	0.317	0.047	0.002	0.226	0.408	6.797	0.000	
Amin	0.060	0.102	0.010	-0.140	0.260	0.587	0.557	
Corona	0.050	0.041	0.002	-0.031	0.131	1.216	0.224	
Autio-Gold	-0.244	0.102	0.010	-0.444	-0.044	-2.389	0.017	
Total	**0.093**	**0.046**	**0.002**	**0.004**	**0.182**	**2.039**	**0.041**	



Heterogeneity:

Cochrane Q-value = 81.718 P-value = 0.000 I-squared = 86.539 Tau-squared = 0.020

Therefore, according to this review and Bagherian's review on adhesive systems before fissure sealants,[13] it seems that using flowable composite as a fissure sealing material in clinical practice can be a good alternative in fissure sealant treatment, specifically when it is combined with an adhesive system; although, the findings of this study points to the need for further clinical research to achieve a more reliable clinical implication.

Conclusion

The use of flowable composite as fissure sealing material can slightly increase the retention of sealants compared with conventional resin-based sealants.

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