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Retention of Resin-Based Pit and Fissure Sealants Placed With Versus Without a Bonding Agent: A Narrative Review

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Abstract

Resin-based pit and fissure sealants are an established, minimally invasive method for reducing occlusal caries risk; however, their effectiveness depends on long-term retention. Acid etching alone does not always achieve complete resin penetration, particularly in narrow or contaminated fissures, and placing a bonding agent beneath the sealant has therefore been proposed to improve retention. PubMed/MEDLINE and the Cochrane Library were searched for studies published between January 1990 and September 2026. Eighteen clinical trials and three systematic reviews comparing resin-based sealants placed with and without a bonding agent were included. Eleven trials reported better retention with a bonding agent, five found no significant difference, one favored omitting it, and in one, the result depended on the adhesive used. The benefit was most consistent when conditions were unfavorable, namely, salivary contamination, hypomineralized or carious enamel, and buccal or palatal fissures. Trials that emphasized optimal placement conditions found no difference. Etch-and-rinse adhesives, and self-etch adhesives applied after phosphoric acid etching, performed better than self-etch adhesives used alone. A 2026 systematic review rated the certainty of this evidence as very low but was limited to one trial design. The present review covers a broader evidence base, examines why the trials disagree, and summarizes the findings as situation-specific recommendations. Current evidence does not support routine use of a bonding agent beneath all resin-based pit and fissure sealants; however, selective application appears beneficial when moisture control or enamel quality compromises conventional sealant retention.

Categories: Public Health, Pediatrics, Dentistry
Keywords: bonding agent, pit and fissures, sealants, self-etch adhesive, total-etch adhesive

Introduction And Background

Dental caries remains one of the most common chronic diseases of childhood. The occlusal pits and fissures of permanent molars are particularly vulnerable because their narrow, irregular anatomy is difficult to clean and retains plaque [1]. Pit and fissure sealants were introduced as a preventive strategy by Buonocore in 1970, who bonded a resin to acid-etched enamel to seal these sites [2]. Cochrane review evidence supports their effectiveness: compared with no sealant, resin-based sealants reduce caries by an estimated 11-51% at 24 months, with a similar benefit at 48 months [3]. This protection lasts only as long as the sealant is retained. A partially or completely lost sealant no longer protects the fissure [4].

Resin-based sealants are conventionally placed after the enamel has been etched with phosphoric acid. Etching creates a microporous surface into which the low-viscosity resin flows and forms retentive tags [4]. Placing a separate bonding agent between the etched enamel and the sealant, a step borrowed from restorative dentistry, has been proposed to improve resin penetration in poorly accessible fissures and in fields prone to salivary contamination [5,6]. Early clinical studies tested this approach, and Feigal et al. reported improved retention with a bonding agent, particularly on contamination-prone surfaces [7].

A bonding agent is a low-viscosity resin that contains both hydrophilic and hydrophobic monomers [5]. In theory, it improves wetting of irregular fissure walls, tolerates small amounts of moisture, and produces a more continuous network of resin tags in steep, narrow fissures [8,9]. In a laboratory study, applying a bonding agent before the sealant increased microtensile bond strength and improved the sealant-enamel interface [10]. The additional step also has costs. It adds chair time, material expense, and technique sensitivity, and some adhesives etch enamel less aggressively than phosphoric acid [8]. Whether these laboratory advantages translate into better clinical retention is uncertain, because sealants are often placed on erupting teeth under variable isolation.

The current evidence-based guideline of the American Dental Association and the American Academy of Pediatric Dentistry addresses sealant indications and materials but does not evaluate the use of a separate bonding agent [11]. A recent systematic review synthesized randomized split-mouth trials that compared sealants placed with and without a bonding agent after acid etching and rated the certainty of the evidence as very low [12]. That review was deliberately limited to one trial design, and it did not explain why the trials

disagree or offer chairside guidance. The present review was undertaken to address these gaps. It considers a broader body of clinical evidence, examines the clinical factors that may explain the conflicting results, and translates the findings into situation-specific recommendations for pediatric practice.

Review

Methods

PubMed/MEDLINE and the Cochrane Library were searched for articles published between January 1, 1990, and September 30, 2026. Both searches were run on October 8, 2026. The PubMed search used the following strategy, with no filters other than the publication date range: ("Pit and Fissure Sealants"[MeSH] OR "fissure sealant*"[tiab]) AND ("Dental Bonding"[MeSH] OR "Dentin-Bonding Agents"[MeSH] OR "bonding agent*"[tiab] OR "adhesive system*"[tiab]) AND (retention[tiab] OR survival[tiab] OR "randomized controlled trial"[pt]) AND 1990/01/01:2026/09/30[dp]. The Cochrane Library was searched in the title, abstract, and keyword fields with the strategy ("fissure sealant*") AND ("bonding agent*" OR "adhesive system*") AND (retention OR survival), without filters; all retrieved records fell within the date range. The language restriction was applied during screening. The reference lists of the retrieved systematic reviews were also screened manually.

PubMed/MEDLINE was selected because it indexes the core clinical dental literature. The Cochrane Library was selected because its Central Register of Controlled Trials is the most comprehensive single source of controlled clinical trials and also includes trial registrations. Other databases, such as Scopus and Embase, were not available to the author, and this is acknowledged as a limitation.

Clinical trials, systematic reviews, and meta-analyses published in English were eligible if they compared the clinical retention of resin-based pit and fissure sealants placed with and without an adhesive or bonding step after acid etching in children or adolescents. The following were excluded: in vitro studies, case reports, trial registrations without published results, studies of glass ionomer sealants, trials conducted in adults, trials that compared adhesives without a sealant-only control group, and trials that used a self-etch adhesive in place of, rather than after, phosphoric acid etching. One trial of an analogous preparatory step for a giomer-based sealant was retained and is discussed separately because it informs the broader question of enamel surface preparation.

The author screened titles and abstracts, assessed the full texts of potentially relevant articles, and extracted the study design, sample, materials, follow-up, retention outcomes, and conclusions into a standardized table. The search identified 281 records (228 from PubMed and 53 from the Cochrane Library). After 37 duplicates were removed, 244 records were screened, and 32 full-text articles were assessed for eligibility. Twelve were excluded because they lacked a sealant-only control group or replaced phosphoric acid etching with a self-etch adhesive (n=10), enrolled adults (n=1), or could not be retrieved in full text (n=1). The remaining 20 articles and two identified through reference lists were included, giving 22 studies: 18 clinical trials, three systematic reviews, and one trial of a giomer-based sealant. The selection process is summarized in Figure *1*.

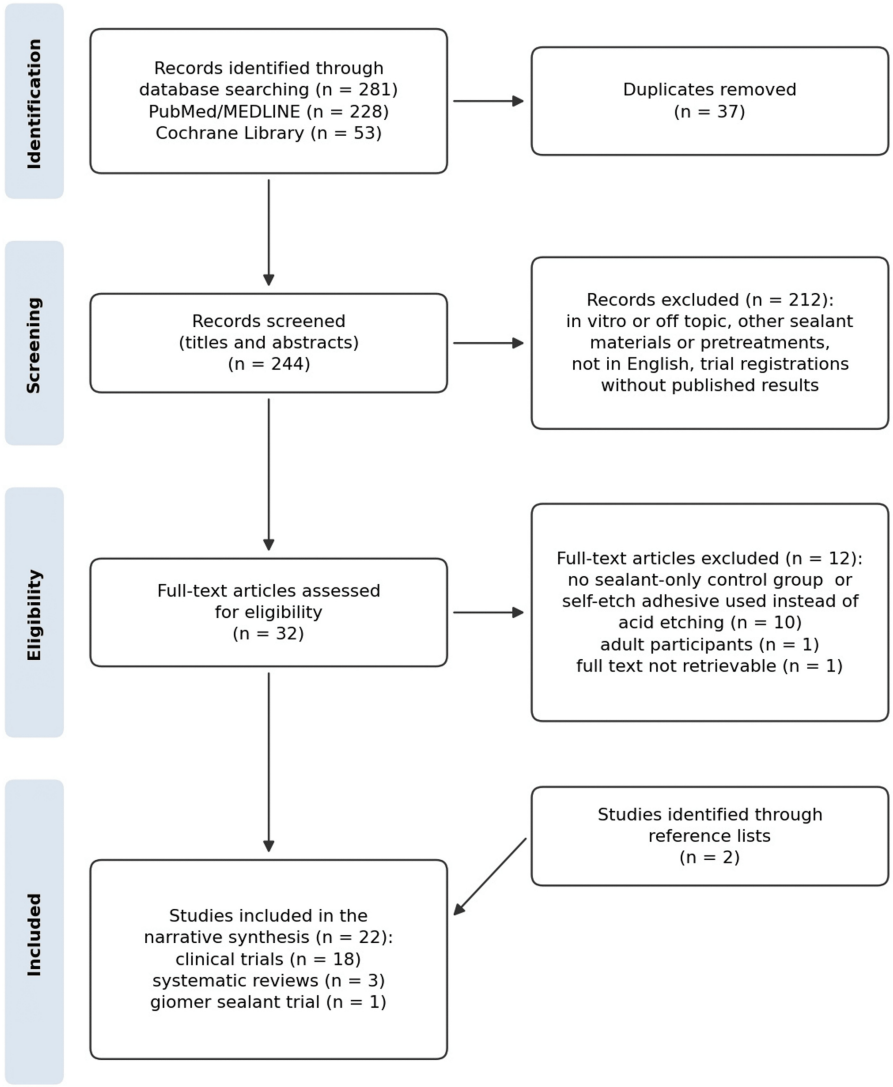


FIGURE 1: Flow diagram of study identification, screening, eligibility assessment, and inclusion

Because the trials differed in materials, protocols, retention criteria, and follow-up, and most did not report paired data suitable for pooling, a meta-analysis was not attempted. Instead, each trial was classified according to the direction of its retention finding: better retention with a bonding agent, no significant difference, better retention without a bonding agent, or a result that depended on the adhesive used. These groups were then compared narratively. No formal risk-of-bias assessment was performed.

Results

Clinical Trial Evidence

The characteristics and main retention findings of the 18 clinical trials are summarized below. Most used a split-mouth design in children aged 5-15 years and assessed retention between six months and five years after placement.

Eleven trials reported better retention with a bonding agent. In one of the earliest, a two-year trial in which enamel was deliberately contaminated with saliva, Feigal et al. showed that sealants could be retained on wet enamel when a bonding agent was placed beneath them [6]. The same group later reported improved retention with both two-bottle and single-bottle adhesive systems, particularly on contamination-prone surfaces [7]. In 112 children aged 5-15 years, McCafferty and O'Connell found that an ethanol-based adhesive significantly increased retention at 12 months (p=0.0005). The difference was small on occlusal surfaces (98% versus 93%) but larger on buccal and palatal fissures (92% versus 82%), and the child's behavior during placement also significantly affected retention [13]. In 98 children with occlusal caries

scored 2-4 on the International Caries Detection and Assessment System (ICDAS) [14], Kasemkhun et al. reported 24-month retention of 83.3% with a bonding agent and 53.7% without (p<0.001), with no difference in caries progression [15]. In molars affected by molar-incisor hypomineralization (MIH), Lygidakis et al. found that 70.2% of sealants placed with a single-bottle adhesive remained fully intact after four years, compared with 25.5% of those placed after etching alone (p<0.001) [16].

The remaining six trials in this group compared several adhesive protocols. Erbas Unverdi et al. found that an etch-and-rinse adhesive, or a self-etch adhesive applied after phosphoric acid etching, gave significantly better 24-month retention than either a conventional sealant or a self-etch adhesive used without prior etching [17]. Khare et al., in 52 children aged 6-10 years, reported that etch-and-rinse, universal, and self-etch adhesives applied after acid etching all improved retention compared with acid etching alone [18]. In a three-year trial of 346 molars and premolars in 87 children, Sakkas et al. found that etch-and-rinse adhesives provided better long-term fissure sealing than acid etching alone [19]. In newly erupted maxillary molars, Nogourani et al. found that both an etch-and-rinse and a self-etch adhesive retained sealants better than sealant alone [20]. Mathew et al. reported significantly better 12-month retention of two different sealants when a self-etch adhesive was added [21]. Rishika et al. observed better marginal integrity and anatomic form at 12 months when enamel deproteinization was combined with an intermediate bonding layer, although this combined intervention does not allow the effect of bonding to be isolated [22].

Five trials found no significant difference. Pinar et al. reported 24-month retention of 79% with a one-bottle bonding agent and 75% without in 30 children and concluded that sealant success depends mainly on placement under optimal conditions [23]. Mascarenhas et al., in 78 children aged 6-9 years, found complete retention at two years in 64% of sealants placed with a primer and bond and in 68% of those placed without (p=0.22), with no difference in caries [24]. Moreira et al. followed 260 molars in 65 children for 24 months and found that the adhesive layer did not significantly affect retention (p=0.28), whereas the eruption stage of the tooth did (p=0.004) [25]. Bandi et al. recorded 12-month retention of 80% with a bonding agent and 72% without in 100 molars of 25 children, a nonsignificant difference [26]. Nirwan et al. compared sealants placed without a bonding agent with sealants bonded using sixth-, seventh-, and eighth-generation adhesives in 148 teeth from 37 children over six months. Retention was highest without a bonding agent, although the differences were not significant, and the authors attributed sealant loss mainly to moisture control and handling [27].

In one trial, the result depended on the adhesive. Tandon et al., in 64 children aged 6-9 years, found that sealants placed with a fifth-generation adhesive were retained significantly less well than sealants placed alone, whereas a seventh-generation adhesive did not differ significantly from sealant alone at 12 months [28].

One trial favored omitting the bonding agent. Vishwakarma et al. evaluated retention according to fissure morphology in a split-mouth trial. Twelve months after placement, 60% of sealants survived in fissures of altered morphology treated without a bonding agent, compared with 36% in comparable fissures treated with one, a significant difference [29].

Table *1* presents the characteristics and main retention findings of the 18 clinical trials.

Study	Design and sample	Follow-up	Adhesive	Retention (with vs. without bonding agent)
Feigal et al., 1993 [6]	Split-mouth; 92 children; 290 molars; intentional salivary contamination	2 years	Bonding agent	Sealants retained on saliva-contaminated enamel when a bonding agent was used
Feigal et al., 2000 [7]	Randomized split-mouth; 152 children; 617 occlusal and 441 buccal/lingual sealants	Up to 5 years	Two-bottle and single-bottle adhesives	Better retention with bonding agents, especially on contamination-prone surfaces
McCafferty and O'Connell, 2016 [13]	Split-mouth; 112 children aged 5-15 years; 390 molars	12 months	Ethanol-based adhesive	Occlusal 98% vs. 93%; buccal/palatal 92% vs. 82%; overall p=0.0005
Kasemkhun et al., 2021 [15]	Split-mouth; 98 children aged 7-9 years; 120 molar pairs with ICDAS 2-4 caries	24 months	Adper Single Bond 2 (etch-and-rinse)	83.3% vs. 53.7%; p<0.001
Lygidakis et al., 2009 [16]	Split-mouth; 54 children aged 6-7 years with MIH molars	4 years	Single-bottle (fifth-generation) adhesive	Fully sealed 70.2% vs. 25.5%; p<0.001
Erbas Unverdi				Etch-and-rinse and etch plus self-etch

et al., 2017 [17]	Split-mouth; 57 children; 228 molars; four groups	24 months	Etch-and-rinse; self-etch with and without prior etching	better than sealant alone ($p<0.05$); self-etch alone no better
Khare et al., 2017 [18]	Randomized split-mouth; 52 children aged 6-10 years	12 months	Etch-and-rinse, universal, and self-etch adhesives after etching	Adhesive after etching improved retention vs. acid etching alone
Sakkas et al., 2013 [19]	Randomized split-mouth; 87 children aged 6.5-11.5 years; 164 first molars and 182 premolars	3 years	Etch-and-rinse (Optibond FL, Optibond Solo Plus); self-etch (Prompt L-Pop)	Better sealing with etch-and-rinse adhesives than acid etching alone
Nogourani et al., 2012 [20]	Split-mouth; 35 children aged 6-8 years; newly erupted maxillary molars	12 months	Etch-and-rinse or self-etch adhesive	Adhesive 31.3-81.3% vs. sealant alone 6.3-20%, depending on groove
Mathew et al., 2021 [21]	70 children; 280 molars; two sealants	12 months	Self-etch adhesive	Significantly better retention with adhesive for both sealants
Rishika et al., 2018 [22]	206 mandibular first molars	12 months	Bonding agent plus enamel deproteinization	Better marginal integrity and anatomic form with combined protocol (significant)
Pinar et al., 2005 [23]	Split-mouth; 30 children aged 8-10 years	24 months	One-bottle adhesive	79% vs. 75%; not significant
Mascarenhas et al., 2008 [24]	Within-mouth comparison; 78 children aged 6-9 years	24 months	Primer and bond	Complete retention 64% vs. 68%; $p=0.22$
Moreira et al., 2017 [25]	Split-mouth; 65 children aged 6-10 years; 260 molars	24 months	Two adhesives with two sealants	No significant effect of adhesive ($p=0.28$); eruption stage significant ($p=0.004$)
Bandi et al., 2020 [26]	25 children aged 6-9 years; 100 molars	12 months	Bonding agent	80% vs. 72%; not significant
Nirwan et al., 2017 [27]	Split-mouth; 37 children; 148 teeth	6 months	Sixth-, seventh-, and eighth-generation adhesives	Highest retention without adhesive; not significant
Tandon et al., 2015 [28]	Split-mouth; 64 children aged 6-9 years; 256 molars	12 months	Fifth- and seventh-generation adhesives	Fifth-generation 56.3% vs. 79.7% (significantly lower); seventh-generation 85.9% (not significant)
Vishwakarma et al., 2025 [29]	Split-mouth; 50 children	12 months	Bonding agent	Altered-morphology fissures: 36% vs. 60%; favored no bonding agent

TABLE 1: Clinical trials comparing the retention of resin-based pit and fissure sealants placed with and without a bonding agent

Retention figures are given as with versus without a bonding agent.

MIH: molar-incisor hypomineralization; ICDAS: International Caries Detection and Assessment System

Systematic Reviews and Meta-Analyses

In a systematic review and meta-analysis, Bagherian et al. concluded that adhesive use improved retention compared with sealants placed without an adhesive and that etch-and-rinse adhesives outperformed self-etch adhesives [8]. Botton et al., focusing on self-etch adhesive systems, found that these generally produced lower sealant retention than the conventional acid-etch technique [9]. Most recently, Lee et al. synthesized nine randomized split-mouth trials involving 581 children that compared sealants placed with and without a bonding agent after acid etching [12]. Some trials favored the bonding agent, whereas others showed little difference, and new carious lesions on initially sound teeth were rare in both groups. Using the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach [30], the authors rated the certainty of evidence as very low for retention and low for new caries.

Discussion

Summary of Main Findings

Of the 18 trials reviewed, 11 reported better retention with a bonding agent, five found no significant difference, one favored omitting it, and one reported a result that depended on the adhesive used. The direction of effect therefore favors a bonding agent overall, but the size of the benefit varied widely between trials. The most informative finding is that this variation follows a consistent pattern related to the clinical conditions under which sealants were placed.

Comparison of Supporting and Nonsupporting Evidence

The trials that favored a bonding agent largely shared unfavorable placement conditions. They included deliberate salivary contamination [6], contamination-prone surfaces [7], buccal and palatal fissures [13], carious enamel [15], and hypomineralized enamel [16]. In contrast, two of the five trials that found no difference concluded that a bonding agent adds little when the sealant is placed under optimal conditions with proper technique [23,24]. The trials that did not support a bonding agent also had other explanations for their results: eruption stage, rather than the adhesive, determined retention in one [25], a multistep fifth-generation adhesive performed worse than sealant alone in another [28], and mechanically modified fissures responded poorly to an additional resin layer in a third [29].

These findings agree with the earlier meta-analyses, which favored adhesive use and identified the type of adhesive as an important determinant of outcome [8,9]. They are also consistent with trials that were not eligible for this review because they lacked a sealant-only control group. In those trials, conducted in young adults, a nanofilled sealant placed with an etch-and-rinse adhesive was retained in 81.6% of cases at 24 months, compared with 15.8% with a one-step self-etch adhesive, and the difference persisted at 48 months [31,32]. Laboratory evidence of higher bond strength and improved interface morphology with a bonding agent [10] supports the clinical benefit seen under difficult conditions. However, clinical differences under good isolation were small, which suggests that a well-etched, dry enamel surface already provides sufficient micromechanical retention for a sealant. This differs from restorative dentistry, in which adhesives are integral to bonding composite resins to dentin [5].

Factors Influencing Retention

Five factors appear to determine whether a bonding agent improves retention. The first is moisture control: the clearest benefits were seen on saliva-contaminated enamel and on buccal and palatal fissures, which are harder to isolate [6,7,13]. The second is the condition of the enamel, with the largest benefits reported on hypomineralized enamel [16] and on non-cavitated or early cavitated carious lesions [15]. The third is adhesive chemistry. Etch-and-rinse adhesives, and self-etch adhesives applied after phosphoric acid etching, outperformed self-etch adhesives used alone [8,9,17], although a multistep fifth-generation adhesive performed worse than sealant alone in one trial [28]. The fourth is tooth and fissure morphology. Eruption stage strongly influenced retention regardless of the adhesive [25], and mechanically modified fissures may respond differently from untouched fissures [29]. The fifth is follow-up duration, since differences observed at three or six months do not always persist to 12 months or beyond [18,26].

Related Evidence on Enamel Preparation for Giomer Sealants

One trial examined a related but different question: whether etching enamel before placing a giomer-based sealant, which contains surface pre-reacted glass ionomer (S-PRG) filler, improves retention. Elmokanen and Gad randomized 52 patients to receive the sealant with or without prior etching and found a 69% lower risk of total or partial sealant loss at 12 months when etching preceded placement [33]. Because this trial evaluated surface preparation rather than a resin bonding agent, it was not included in Table *1* or in the trial counts above. It nevertheless shows that preparing the enamel surface can substantially affect the retention of some sealant materials.

Clinical Recommendations

These findings do not support adding a bonding agent beneath every resin-based sealant [8,12]. When a tooth is fully erupted, the enamel is sound, and isolation is reliable, well-executed acid-etch sealant placement appears sufficient, and the extra chair time, cost, and technique-sensitive step are difficult to justify [23-25]. A bonding agent appears worthwhile when salivary contamination is likely, on buccal and palatal fissures and when the enamel is hypomineralized or carious [6,13,15,16]. In these situations, an etch-and-rinse adhesive, or a self-etch adhesive applied after phosphoric acid etching, should be preferred to a self-etch adhesive used alone, and it should be applied carefully [8,9,17,28]. These recommendations are summarized in Table *2*. The evidence for any additional caries-preventive benefit, beyond retention itself, is of low to very low certainty [12].

Clinical situation	Bonding agent	Basis
Fully erupted tooth, sound enamel, and reliable isolation	Not routinely needed	No significant retention difference under good placement conditions [23-25]
Risk of salivary contamination	Recommended	Better retention on saliva-contaminated and contamination-prone enamel [6,7]
Buccal and palatal fissures	Recommended	Larger benefit than on occlusal surfaces: 92% vs. 82% retention at 12 months [13]
Hypomineralized enamel (MIH)	Recommended	Fully sealed 70.2% vs. 25.5% at 4 years[16]
Non-cavitated or early cavitated carious lesions (ICDAS 2-4)	Recommended	Retention 83.3% vs. 53.7% at 24 months[15]
Partially erupted molars	Benefit uncertain	Eruption stage affected retention regardless of adhesive use; close monitoring and resealing are advisable [25]
Mechanically modified fissures	Not recommended (limited evidence)	Lower retention with a bonding agent in one trial[29]
Choice of adhesive when one is used	Etch-and-rinse or self-etch after phosphoric acid etching	Self-etch adhesives used alone retain sealants less well; multistep systems require careful technique [8,9,17,28]

TABLE 2: Suggested use of a bonding agent beneath resin-based pit and fissure sealants according to clinical situation

Recommendations are based on low-certainty evidence and should be applied with clinical judgment.

MIH: molar-incisor hypomineralization; ICDAS: International Caries Detection and Assessment System

Strengths and Limitations

This review has several strengths. It includes twice as many clinical trials as the most recent systematic review, because it is not restricted to one trial design [12]. It considers clinical factors that earlier reviews did not examine in detail, namely, enamel condition, including MIH and carious enamel, surface location, child behavior, eruption stage, fissure morphology, and adhesive generation. It also links these factors to situation-specific recommendations. The search strategies, eligibility criteria, selection process, and extracted data are fully reported, so the findings can be checked and updated.

The review also has limitations. Screening, eligibility assessment, and data extraction were performed by a single author without independent verification. This introduces a risk of selection bias and of errors in classifying trial results, which could have altered the number of trials assigned to each outcome group. This risk was reduced by applying predefined eligibility criteria, by searching two databases and the reference lists of systematic reviews, and by reporting the extracted data for every trial in Table *1*. However, it cannot be excluded. In addition, no formal risk-of-bias assessment was undertaken, only two databases were searched, and studies not published in English were excluded. Many trials were small, some combined the bonding step with other interventions, and the trials differed in materials, retention criteria, and follow-up, which precluded a meta-analysis.

Conclusions

Current evidence does not support routine use of a bonding agent beneath all resin-based pit and fissure sealants. However, selective application appears beneficial in situations in which moisture control or enamel quality compromises conventional sealant retention, such as a risk of salivary contamination, buccal and palatal fissures, and hypomineralized or carious enamel. When a bonding agent is used, an etch-and-rinse adhesive, or a self-etch adhesive applied after phosphoric acid etching, is preferred. Because the certainty of the evidence is low, larger standardized trials with consistent retention criteria and longer follow-up are needed.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

Concept and design: Nahla S. Al Ibrahim

Acquisition, analysis, or interpretation of data: Nahla S. Al Ibrahim

Drafting of the manuscript: Nahla S. Al Ibrahim

Critical review of the manuscript for important intellectual content: Nahla S. Al Ibrahim

Supervision: Nahla S. Al Ibrahim

Disclosures

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