11 Retention of Fissure Sealants

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Abstract

Sealant retention is a commonly used outcome measure for sealant materials, for example, in clinical trials. Retention rates are also used to inform practitioners about the clinical performance of a sealant material and thereby guiding them in the decision for the preferable sealant. However, the association between sealant retention and the prevention or management of carious lesions is questionable. In this chapter, we will discuss why this is and present data as to the retention of different sealants materials. Moreover, factors that may influence sealant retention will be discussed in depth, and clinical recommendations to improve retention will be given.

11.1 Sealant Retention and Clinical Efficacy

Sealants are placed on pits and fissures that are susceptible to carious lesion development and/or progression, in order to create a physical barrier. This barrier stops the ingress of food and microorganisms into the fissures but also (and possibly mainly) the diffusion of organic acids into the tooth tissues. This barrier thus serves three purposes: (1) making the surface easier to clean, (2) avoiding mineral loss from the tooth tissue, and (3) inhibiting bacterial carbohydrate nutrition and thus metabolism, thereby inactivating bacteria. Thus, it seems reasonable that the clinical efficacy (preventing and managing caries lesions) of a sealant is strongly correlated with its ability to cover all pits and fissures in the

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K. Bekes (ed.), *Pit and Fissure Sealants*,
https://doi.org/10.1007/978-3-319-71979-5_11

long term; retention rates of sealants should thus predict the clinical efficacy of a sealant material [1]. Many clinical studies use retention rate as their primary outcome in order to assess the performance of a sealant. However, doubts exist as to the validity of retention as a surrogate measure for the clinical efficacy of a sealant material.

The assessment of sealants was originally evaluated in clinical trials which compared the occurrence (or prevention) of carious lesions in sealed and non-sealed teeth (often within the same mouth in a split-mouth design). Due to favorable outcomes of sealants, the use of a no-sealant control became ethically unacceptable. Consequently, later studies compared different sealant materials and/or techniques instead of comparing sealed versus non-sealed teeth [2, 3]. As early trials found non-sealed teeth at high risk for lesion occurrence compared to sealed teeth, it was assumed that sealed teeth with complete or partially sealant loss were at the same (or even higher [4]) risk for lesion development as never-sealed teeth. Regression analyses of fissure sealant trials have supported this theory, showing a positive association between retention rate and lesion occurrence [5]. It was further argued that sealants can only be effective when they are present on the tooth, and therefore it was claimed that the effectiveness of a sealant is a direct function of its retention [1, 6–8]. Therefore, retention rate of the sealant was broadly accepted as a valid surrogate measure for their clinical efficacy [3, 9].

According to the *Prentice* criteria, valid surrogate endpoints need to (1) reliably predict the true clinical endpoint of a disease and (2) need to be independent from the applied treatment [10]. For sealant retention (as a surrogate for carious lesion prevention), this means (1) sealant retention should be directly associated with the occurrence of lesions and (2) this association should hold true regardless of the applied sealant material (e.g., the association between sealant retention and lesion occurrence should be the same for different sealant materials) [3]. In two systematic reviews, *Mickenautsch* and *Yengopal* assessed if the surrogate endpoint "sealant retention" fulfills these criteria and is thus valid [3, 9]: One review assessed the association between sealant retention as a predictive outcome for lesion occurrence when resin-based fissure sealants were placed in permanent molars for a minimum follow-up of 24 months. It was found that the retention rate, as a predictor for lesion occurrence, was not more accurate than random estimates. The authors concluded that retention rate is not a valid predictor for lesion development but also found that complete retention remains a beneficial clinical factor for a sealant material [9]. The second review assessed if the association between sealant retention and lesion occurrence was the same for different sealant materials. Data from clinical trials and systematic reviews reporting on retention rate and lesion occurrence in permanent molars sealed with resin-based or glass-ionomer cement sealants were included. The risk of complete retention loss was contrasted with the risk of lesion occurrence. Significant differences in the ratios of retention and lesion occurrence values were found between resin-based sealants (mean/SD ratio was 9.64/24.58) and glass-ionomer cement sealants (13.68/13.72). This indicates that the association between retention loss and lesion occurrence was not independent from the used material. In summary, sealant retention does not fulfill the Prentice criteria as a valid surrogate endpoint, while additional regression analyses revealed a significant association between sealant retention and lesion occurrence for resin-based sealants, but not for glass-ionomer cement-based sealants. Interestingly, even after complete loss of glass-ionomer sealants lost, they still provided a carious lesion-preventive effect [3].

As a clinical guide, complete retention of a sealant material may nevertheless contribute to its carious lesion-preventive effect. However, this might not be the only preventive factor. Other known and unknown factors acting independently of the retention rate may contribute to the preventive effect. Therefore, the judgment on the clinical efficacy of a particular sealant material should not only be based on its ability to retain on the tooth surface but also (and possibly mainly) on its ability to prevent carious lesion (and arrest existing ones).

11.2 Caries Risk of Teeth with Lost Sealants

As discussed in previous chapters, fissure sealing is a highly effective treatment for the prevention of carious lesions. However, concerns exist that teeth with lost sealant material may be at a higher risk for new lesions compared with never-sealed teeth. For partially lost sealants, areas next to remaining sealant material might be less cleanable and therefore could represent a predilection site for new lesion development. Another explanation might be that the previously modified tooth surface (e.g., by acid etching) could bear a higher risk compared to a non-modified surface. Particularly for patients where regular inspections of sealed teeth cannot be ensured, these concerns can act as a barrier for providing fissure sealants.

Griffin and *colleagues* assessed the risk of lesion occurrence in formerly sealed teeth by analyzing data from different systematic reviews [4]. The authors compared the lesion incidence in molars of children (aged 5–14 years) where partial or full retention loss occurred, with the lesion incidence of molars that never had been sealed. To allow for comparisons between formerly sealed and never-sealed teeth included studies needed to have used a split-mouth design, where sealed and non-sealed teeth were compared within the same mouth. For all included studies, either UV-light-polymerized or auto-polymerized resin-based sealants were used. After 1 year, the risk of lesion development in teeth with lost sealant versus never-sealed teeth was not different (relative risk, 0.99; 95% CI, 0.82–1.22). After a period of up to 4 years, the caries risk of formerly sealed teeth was even slightly (albeit significantly) lower compared to never-sealed teeth (0.94; 0.90–0.98). It was further found that partially retained sealants could offer some protection against new lesions [11]. The authors concluded that after retention loss of a sealant, teeth do not have an increased risk of developing carious lesions and suggested that sealants should also be provided if indicated even if it cannot be assured that children can attend to regular checkups [4].

For glass-ionomer cement sealants, clinical observations indicate that they still offer some protection even if they got visually completely lost [3]. Using microscopic evaluations of replica of teeth with lost glass-ionomer sealants, it could be shown that in many cases, sealant material remained in place [12]. Due to their brittle nature and their chemical bonding to the tooth surface, glass ionomers tend to fracture cohesively within the sealant layer leaving the tooth surface still covered with a thin layer of glass-ionomer cement. The carious lesion-protective effect of this residual layer might emanate from its diffusion barrier effect but also from its release of fluoride [3, 13, 14].

In summary, teeth with lost sealants may not be at a higher risk for carious lesion development, most likely the opposite. It seems unreasonable to refuse the placement of sealants in less cooperative patients who may not return regularly as a result of fearing retention loss of the sealant in the meantime.

11.3 Retention Rates of Fissure Sealants

11.3.1 Sealant Material Classes

A variety of different sealant materials are commercially available of which two material classes—resin-based sealants and glass-ionomer sealants—are most relevant today (see Chap. 2). Resin-based sealants, which are commonly based on urethane dimethyl (UDMA) or bisphenol A-glycidyl methacrylate (BISGMA) monomers, can either be polymerized by chemical activated initiation (autopolymerization) or photopolymerized by use of visible or UV light [15]. Resin-based sealant materials bond by micromechanical retention to the tooth. To create such a bonding, the tooth surface has to be pretreated (commonly by acid etching). Resin-based materials have advantageous mechanical properties compared to glass-ionomer cements. However, their hydrophobic nature and the more technique-sensitive application are a disadvantage of this material class. Less commonly used modifications of the resins are polyacid-modified resins (or compomers) where properties from resins and glass ionomers (fluoride release, adhesive properties) are being combined [15].

The other predominant sealant materials are glass-ionomer cements. Curing of glass ionomers occurs chemically by an acid-base reaction between a fluoroaluminosilicate glass powder and a polyacrylic acid solution. Due to their ability to chemically bond to the tooth structure, it is not necessary to create a micro-retentive tooth surface (e.g., by acid etching) prior application. Glass-ionomer cements are less susceptible to moisture contamination than resin-based sealants, but their mechanical properties are inferior compared to resin-based materials. However, due to their lower technique sensitivity compared to resin-based materials, they are often used in patients that are less cooperative during treatment. Resin-modified glass-ionomer cements are modifications of glass-ionomer cements. Curing of these materials can be initiated by application of light.

The different sealant material classes vary in their properties (e.g., fracture resistance, bond strength to the tooth structure) and their application technique (e.g., tooth surface pretreatment, contamination control, curing mode). All of these factors might have an influence on the retention of the sealant.

11.3.2 Retention Rates of Different Sealant Materials

In a systematic review, Kühnisch and colleagues [1] meta-analyzed the retention rates for different sealant material classes. Data from the included 23 studies revealed that calculated retention rates of resin-based sealants after 2 years were higher (all were in the range of 84% (auto-polymerizing sealants) to 78% (light-polymerizing sealants)) compared to compomer- and glass-ionomer-based sealants (Table 11.1) with one exception; retention rate for UV-light-polymerizing sealants was considerably lower (51%) compared to the other resin-based sealants. However, it should be noted that UV-light-polymerizing sealants represent the first generation of sealant materials (all of the studies on this sealant class were published between 1971 and 1986) and are no longer available today. For compomer-based sealants, the calculated retention rate after 2 years was as low as for UV-light-polymerizing sealants (52%), and for glass ionomer the 2-year retention rate was lowest (12%) among all included material classes.

After 5 years the study found that light-polymerizing sealants (84%), auto-polymerizing sealants (65%), and fluoride-releasing resin-based sealants (70%) performed best regarding retention rate, whereas glass-ionomer-based sealants (5%), compomer-based sealants (4%), and UV-polymerizing sealants (19%) performed inferior. The authors concluded that glass-ionomer cement- and compomer-based sealants were associated with a considerably lower retention rate than resin-based sealants and did not recommend the use of glass-ionomer cement or compomer-based use in clinical practice [1].

In another systematic review [15], retention rates of different sealant materials were meta-analyzed. Four sealant material categories were assessed: resin-based sealants, glass-ionomer sealants, resin-modified glass-ionomer sealants, and polyacid-modified resin-based sealants (i.e., compomer sealants). Odds ratios and 95% confidence intervals were assessed for the outcomes of the comparisons that have been performed within the included trials, allowing for direct

Table 11.1 Retention rates of different sealant material classes, estimated via meta-analysis (from [1])

Material	% retention rates (95% CI) of sealants over different observation intervals		
	2 years	3 years	5 years
UV-light-polymerizing resin-based sealants	51.1 (37.6–64.0)	38.6 (26.0–52.7)	19.3 (7.9–39.9)
Auto-polymerizing resin-based sealants	84.0 (79.8–87.5)	78.8 (75.3–82.9)	64.7 (57.1–73.1
Light-polymerizing resin-based sealants	77.8 (64.3–88.9)	80.4 (63.6–89.8)	83.8 (54.9–94.7)
Fluoride-releasing resin-based sealants	81.1 (45.8–97.8)	75.3 (59.4–88.8)	69.9 (51.5–86.5)
Compomer-based sealants	52.0 (18.8–94.9)	17.9 (8.2–58.0)	3.8 (0.2–31.8)
Glass-ionomer cement-based sealants	12.3 (7.6–19.0)	8.8 (4.3–13.7)	5.2 (1.3–15.5)

Table 11.2 Risk of sealant retention loss (expressed as odds ratios (OR) and 95% confidence intervals (95% CI)) of different sealant materials (from Ref. [15])

Comparisons	Observation period (years)	Indication (*n* studies)	Comparison OR (95%CI)
GIC vs RB	2–3	Carious or deep fissures (1)	2.50 (2.00–3.11)
		Sound fissures (9)	5.62 (1.26–25.07)
		Total	5.06 (1.81–14.13)
	4–7	Sound and carious fissures (1)	0.56 (0.18–1.76)
		Sound fissure (1)	7.97 (2.19–29.01)
		Total	2.00 (0.15–27.95)
GIC vs RMGIC	2–3	Not reported (1)	3.21 (1.87–5.51)
RMGIC vs PMR	2–3	Sound fissures (1)	1.17 (0.52 – 2.66)
PMR vs RB	2–3	Sound fissures (2)	0.87 (0.12 – 6.21)

GIC glass-ionomer cement-based sealant, *RB* resin-basesd sealant, *RMGIC* resin-modified glass-ionomer sealant, *PMR* polyacid-modified resin-based sealant

Table 11.3 Comparison of risk of carious lesion development (expressed as odds ratios (OR) and 95% confidence intervals (95% CI)) of different sealant materials (from Ref. [15])

Comparisons	Observation period (years)	Comparison OR (95%CI)
GIC vs RB	2–3	0.71 (0.32–1.57)
	4–7	0.37 (0.14–1.00)
GIC vs RMGIC	2–3	1.41 (0.65–3.07)
RMGIC vs PMR	2–3	0.44 (0.11–1.82)
PMR vs RB	2–3	1.01 (0.48–2.14)

GIC glass-ionomer cement-based sealant, *RB* resin-basesd sealant, *RMGIC* resin-modified glass-ionomer sealant, *PMR* polyacid-modified resin-based sealant

comparisons of the different material classes (Table 11.2). After a time interval of 2–3 years, glass-ionomer sealants had a fivefold increased risk of retention loss compared to resin-based sealants, which was statistically significant. After 4–7 years, participants who received glass-ionomer sealants had a (nonsignificant) twofold increased risk of retention loss compared to resin-based sealants. (Conventional) glass-ionomer sealants also had a statistically significant threefold increased risk of retention loss compared to resin-modified glass-ionomer sealants. Risk of retention loss was not statistically different between resin-modified glass-ionomer sealants and polyacid-modified resin-based sealants. Nonsignificant differences were also found for the comparison between polyacid-modified resin-based sealants and resin-based sealants. This review thus confirmed the inferiority of glass ionomers compared to resin-based sealants regarding their retention rate. However, in the same systematic review, the risk of carious lesion development in teeth sealed with the different material classes was also assessed (Table 11.3). No significant differences could be found between the sealant materials, indicating that retention rate may not be a good surrogate for the clinical efficacy of sealants, as discussed above.

11.4 Factors Influencing Sealant Retention

A number of factors have been found to impact on sealant retention. These will be discussed here in depth.

11.4.1 Where to Place Sealants: On Sound or Carious Enamel?

One of the main barriers for dentists to place a sealant is the fear of sealing carious enamel or dentin. While, as discussed in the previous chapters, sealing (at least early) carious lesions is a highly effective and safe therapy for arresting them, the difference in sealing substrate (sound versus demineralized enamel) might have a significant impact on the retention of the sealant (lowering it). We will follow this question and compare the retention rate of (mainly resin based) sealants on these different hard tissues.

As described above, the retention rates of sealants have been analyzed systematically, with annual rates of retention loss ranging between 8% (for auto-polymerizing resin sealants) to 40% (for glass-ionomer cement sealants). Light-polymerizing sealants, compomer sealants, and UV-light-polymerizing sealants range somewhat in between (with annual retention loss rates being 12–25%). For light-polymerizing sealants, these retention loss rates seem to be higher in the first years after sealant placement, with only few sealants being lost after 3–5 years [1]. One can now compare these rates with those yielded by studies sealing enamel carious lesions, as meta-analyzed recently [16]. Note that this meta-analysis could not always ascertain why a sealant was replaced, but we can conservatively assume that partial or total retention loss was the reason. Table 11.4 displays the annual retention loss rates of sealants in these different studies (which span a publication period of 36 years). The mean annual retention loss rate (as sample-sized weighted rate) was

Table 11.4 Annual sealant loss rates (ASLR, in %)

Study	Lost sealants[a]	Total sealants	Follow-up (months)	ASLR (%)
Going (1976)	12	41	24	15
Gibson (1980)	15	58	30	10
Mertz-Fairhurst (1986)	0	14	21	0
Frencken (1996)	139	314	36	15
Mertz-Fairhurst (1998)	37	85	120	4
Florio (2001)	10	29	12	34
Hamilton (2002)	3	113	24	1
Bahshandeh (2012)	7	49	33	5
Borges (2010)	0	26	12	0
da Silveria (2012)	16	27	12	59
Liu (2012)	132	256	24	26
Total	371	1012	32	15

[a]Presumed all failures which were mended not invasively were retention loss. References can be found in the original review [16]

15% (standard deviation, 18%). It should be noted that, as many studies were from the early times of fissure sealing, UV-light-polymerized sealants had been used (some studies even used glass-ionomer sealants). Thus, it is difficult to compare this compound rate with that from different specific materials placed on sound enamel. However, one can state that the pooled retention rate of sealants placed on carious enamel is not significantly lower than that yielded for sealants placed on sound enamel, even when comparing it against the "best" material class on sound enamel (auto-polymerizing sealants). What should additionally be noted is the large range of annual sealant loss rates, something which might be due to a range of further factors impacting on sealant retention.

11.4.2 Prior to Placing the Sealant: Pretreating the Surface or Not?

A major question when placing a sealant is: Do I need to pretreat the enamel, and how can this be done both effectively and efficiently? It is thought that cleaning the surface, for example, increases the access of any conditioner (acid etchant, etc., see below) to the enamel rods as well as the penetration of the sealant material into the pit or fissure, which eventually could translate into better retention. A range of pretreatments have been investigated, for example, chemical and mechanical cleaning using acids, brushing with pumice and brushes or rubber cups, toothbrushing but also air abrasion using alumina oxide, laser treatment (to roughen and disinfect the surface but also recrystallize it), and enameloplasty, i.e., invasive removal of superficial enamel layers (see Chaps. 7 and 8). A recent systematic review has investigated this issue in depth [17].

All studies included in this review used hydrophobic resin-based sealants (i.e., glass-ionomer sealants had not been tested). Two meta-analyses had been performed, one using data from eight studies comparing any kind of surface treatment followed by acid etching versus only acid etching and one on four studies comparing pretreatment without acid etching (i.e., pretreatment as etching substitute) versus acid-etching only of the surface prior sealant treatment. The authors found the retention to be 3.3 (95% CI: 1.8–6.0) times more likely after surface pretreatment than no such pretreatment. No significant difference was found when comparing mechanical versus chemical (acid etching) pretreatment (the odds of retention was 1.5; 95% CI: 0.5–2.9) times.

A number of aspects can be discussed here. First, cleaning with a rubber cup prior to acid etching, but not necessarily cleaning with a bristle brush alone, has been found to improve retention. This is in contrast with another systematic review, which found that cleaning using toothbrushes does not seem to be inferior to cleaning with pumice or prophylaxis paste [18]. The latter might be as some (older) studies used unsuitable prophylactic pastes (containing oils), which could negatively distort findings toward such pastes. However, it might also be difficult to remove pumice or pastes from the fissures, which could explain a possible disadvantage of this technique. Given that use of toothbrushes seems easy and cheap to perform, it might be recommendable from a pragmatic point of view [19]. However, the uncertainty around any such recommendation should be noted.

Mechanical preparation with a bur (a so-called enameloplasty) prior to etching has also been found to increase retention; explanations for this finding range from removal of debris, widening of fissure, increase of the surface energy, and removal of prismless enamel [20]. It is clear, however, that such process involves loss of significant parts of the enamel and in case of sealant loss exposes a fissure which is wider, more plaque retentive and possibly at higher risk of carious lesion development than a fissure which was not prepared invasively. Given that, as discussed above, retention of sealants is not a perfect surrogate for lesion prevention, one should be cautiously weighing both these aspects against each other. We do not advocate invasive preparation of the fissure.

Air abrasion has been found to significantly enhance retention of sealants [20], again possibly due to removal of debris and better sealant penetration into the fissures but also due to removal of the prismless enamel surface and enamel roughening. Similarly, laser application (in the single study included, a carbon dioxide laser was used) might improve retention of sealants [20]. It is further argued that such treatment might have an antibacterial effect; the relevance of which needs to be put into the context of the effect of sealing itself on any residual sealed bacteria and their viability.

As described, the review also found that performing such pretreatments results in similar retention rates as acid etching, which could call for not performing etching but only pretreatments. However, both the efforts needed for pretreatment (cleaning or preparing the surface is time intensive, application of the laser or air abrasion generates additional costs for devices and materials) and the possible side effects (as discussed, mechanically pretreated surfaces might be at higher risk for carious lesions) should be considered. Thus, there is currently no argument to make against acid etching (replacing it by bur, laser or air abrasion). As the authors of the review conclude: “Acid etching before sealant application is favorable because it roughens the surface without destroying the anatomy of the pits and fissures” [17].

11.4.3 A Separate Step: Using an Adhesive or Not?

Given that most sealants are un- or lowly filled resins, their polymerization shrinkage is high. Together with the disadvantageous formation of to-be-sealed fissures (a cavity with a high configuration factor), shrinkage forces might be overproportionally high during polymerization. Such shrinkage, in turn, could lead to debonding from the enamel surface, which eventually would allow leakage and possible induction or progression of carious lesions.

It has been hypothesized that using a low-elastic modulus intermediate material like an adhesive (see Chap. 8), which additionally might increase retention by better penetrating the fissure and the exposed acid-etched conditioned surface, could reduce the risk of debonding and leakage. The comparison of using an adhesive after acid etching and prior to placing the sealant versus not using such adhesive has been the focus of a recent systematic review [21]. Overall, 12 studies were included, with mixed levels of quality. These were also meta-analyzed and found that using an adhesive increased the chance of sealant retention by more than three times (OR, 3.3 (95% CI, 1.3–8.4)). The authors further compared which adhesive system might be better suited to be used prior to placing the sealant; etch-and-rinse adhesives (where an acid is used for conditioning, as discussed above; this could still be regarded as the standard but comes with a multistep process of etching, rinsing, and placing the adhesive) versus self-etch adhesives (these combine all these steps, decreasing the time needed for treatment and reducing the risk of handling failure). The authors also submitted this comparison to meta-analysis and found the chance of sealant retention to be 14 times (95% CI, 2.6–81) more likely when using etch-and-rinse versus self-etch adhesives.

The authors conclude that using an adhesive after acid etching improves retention, while using self-etch adhesives and thus omitting the etching step is rather disadvantageous. These findings—acid etching being the strategy of choice for enamel bonding, followed by placement of an adhesive—are in line with findings from the general field of restorative adhesive dentistry [22]. The authors, however, could not make clear recommendations as to which etch-and-rinse adhesives (3- or 2-step etch-and-rinse; or water- versus ethanol- versus acetone-solved adhesives) could be most recommendable. In general, however, it can be stated that enamel should be etched prior to placing a sealant. This ensures removal of prismless enamel, reliable and sufficient surface roughening, an increase of the surface energy, and thus good penetration of the resin afterward. Afterward, an adhesive system could be placed if retention is of utmost importance or any other factors possibly compromising sealant retention are present. Such use of a separate adhesive and the resulting possibly higher retention rate should be balanced against the additional efforts and, indirectly, costs coming with it.

11.4.4 Who Should Place Sealants: Dentists or Dental Care Professionals?

Given their proven clinical efficacy, dental sealants would, ideally, be placed on large populations in general dental care but also schools, etc. (in fact, school-based sealant programs, etc., exist all over the world). Moreover, the steps needed for sealing pits and surfaces are relatively non-complex. Consequently, dental care professionals (also termed dental auxiliaries) might be suited to placing sealants, with significant cost savings but also an impact on the availability in settings which are not regularly visited by dentists (like schools). A recent Cochrane review has assessed this issue, comparing retention rates of sealants placed by dentists versus dental auxiliaries [23].

The authors included 4 studies (with 6 auxiliaries and 4 dentists on a total of 1023 participants who received sealants). Three studies found, after a median observation period of 12 months, no significant difference in retention rates between the two groups, while one study (48 months follow-up) found higher retention rates in dentists (29%) versus auxiliaries (9%). There was no consistent definition of what an auxiliary is, and generally, the low number of providers makes any conclusions very hard (it could be that the four dentists were excellent performers, while the six auxiliaries were not, or vice versa; the risk of finding any differences by chance and thus coming to erroneous conclusions is thus very high).

In many settings, it is unlikely that dentists will place any sealants, while provision of sealants by auxiliaries could increase the access to this preventive therapy especially for the neediest (those with low income, who don't attend the dentist regularly and rely on setting approaches, etc.). Thus, one could cautiously conclude that the lack of evidence toward dentists being the better performers allows to recommend sealing by dental auxiliaries in such settings.

11.4.5 How to Place Sealants: Four Handed or Not?

For placing sealants, the handling is crucial, as (a) most sealant materials need to be placed under stringent contamination/moisture control and (b) sealant placement is usually performed in children, where treatment times need to be short. Thus, it is a matter of debate if placement of sealants should be performed four handed or if it is also possible (and would save significant resources) to have sealants placed by only one professional. Sealant retention after four- versus two-handed placement was the focus of a recent systematic review [19].

Eleven studies were included. Retention rates were found to vary significantly between studies both when annualized but also over the different observational periods. Pooled sealant retention rates in studies using four-handed placement were 90% after 1 year, 83% after 2 years, and also 83% after 3 years. These were significantly higher than those from studies using two-handed placement (85% after 1 year, 72 and 68% after 2 and 3 years). The authors concluded that retention rates were significantly higher when sealants are placed four versus two handed; the mean difference was 9%. It is noteworthy that this review found dentists to be the poorer performers for sealant placement (which supports the conclusion made for the former question).

11.5 Recommendations for Sealant Application

- Judgment on the performance of a sealant material should not solely be based on its retention rate.
- Lack of willingness to attend regular recalls is no argument against placement of sealants as teeth with lost sealant material are not at a higher caries risk.
- Sealants can be safely applied on sound enamel and also enamel carious lesions. Placing sealants on enamel carious lesions does not seem associated with significantly decreased retention.
- The tooth surface should be cleaned with a toothbrush and water, or cups/brushes, and pumice/pastes. Given current evidence being inconclusive, a pragmatic

approach might be chosen here. Cleaning increases sealant retention but also ensures correct diagnosis of the fissure or pit status.

- Invasive (mechanical, air abrasion, laser) preparation of the enamel is not necessarily recommended prior to placing sealant: While it might increase sealant retention in some cases, there is insufficient evidence to show that it also increases the preventive effect of sealants. In contrast, in case of sealant loss, prepared (opened, widened, significantly roughened) surfaces could be at higher risk for carious lesion development.
- Acid etching is a crucial conditioning step and should not be omitted, but performed carefully, as it ensures surface roughening, removal of prismless enamel, and penetration of the sealant into the micro-retentive surface.
- An adhesive can be used after acid etching to increase retention. It cannot replace acid etching.
- Sealants can be applied by both dentists and dental care professionals. While current evidence does not necessarily see dental care professionals to be superior to dentists with regards to sealant retention rates, it also does not support the opposites (dentists being more successful).
- A four-handed technique should be used for placement of sealants, as this increases retention.

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