

Fissure Sealant: A Review Article

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Abstract

Review Article

Pit and fissure sealants are a cornerstone of modern preventive dentistry. Their ability to physically block caries-prone occlusal surfaces significantly reduces the risk of dental decay. This article provides an in-depth examination of the history of sealant development, detailed clinical indications and contraindications, a classification of available material types, best-practice clinical procedures, documented benefits, a summary of recent AAPD evidence-based recommendations, and a complete reference list in Vancouver style.

Keywords: Preventive dentistry, Pit and fissure sealants, Resin-based sealants, Glass ionomer sealants, Caries prevention, AAPD guidelines.

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1. History of Fissure Sealants

The concept of sealing pits and fissures emerged from the pioneering work of Michael Buonocore in 1955. Buonocore demonstrated that etching enamel with phosphoric acid created microscopic porosities, allowing acrylic resins to bond mechanically to the tooth surface [1]. This discovery challenged the then-dominant belief that adhesion required mechanical undercuts.

- **1960s:** The first generation of sealants, based on cyanoacrylates and later BIS-GMA resins, were introduced. Early retention was poor due to limited etching technology [2].
- **1970s:** The introduction of ultraviolet (UV) light-cured sealants improved retention but raised safety

concerns regarding UV exposure. Visible light-cured systems soon followed [3].

- **1980s–1990s:** Glass ionomer sealants emerged, offering fluoride release and moisture tolerance, though with lower wear resistance [4].
- **2000s–present:** Resin-modified glass ionomers (RMGI) and fluoride-releasing resin sealants have become widespread. Systematic reviews have firmly established sealants as superior to fluoride varnish alone for occlusal surfaces [5].

2. Indications and Contraindications

Based on evidence-based clinical guidelines [6,7], the use of fissure sealants is recommended under specific conditions.

Indications

Indication	Description
Preventive	Deep, retentive pits and fissures in permanent molars and premolars, primary molars (especially in high-caries-risk children), and teeth with incipient non-cavitated lesions.
Therapeutic	Sealing over active, non-cavitated carious lesions (ICDAS code 1 or 2) to arrest demineralisation.
Special populations	Patients with special health care needs, xerostomia, or orthodontic appliances that hinder oral hygiene.

Timing: Ideally within 4 years of tooth eruption and as soon as the occlusal surface can be isolated adequately (usually soon after complete eruption) [8].

Contraindications

- Frank cavitation (ICDAS code 3–6) requiring restorative treatment.
- Proximal caries extending into the occlusal fissure.

- Inability to achieve adequate isolation (e.g., partially erupted tooth with operculum).
- Well-coalesced, self-cleansing shallow fissures in a low-caries-risk individual.

3. Types of Fissure Sealants

Sealants are classified by composition, setting mechanism, and colour.

3.1 Resin-Based Sealants (RBS)

- **Composition:** BIS-GMA, TEGDMA, initiators, fillers.
- **Setting:** Light-cured (most common) or auto-polymerised.
- **Advantages:** High retention, wear resistance, good mechanical properties.
- **Disadvantages:** Technique-sensitive (requires dry field), no intrinsic fluoride release (unless fluoride is added as a filler).
- **Subtypes:** Unfilled (low viscosity, deep penetration), filled (higher wear resistance), and fluoride-releasing resin sealants [9].

3.2 Glass Ionomer Sealants (GI)

- **Composition:** Aluminosilicate glass + polyalkenoic acid.
- **Setting:** Acid-base reaction.
- **Advantages:** Moisture-tolerant, chemical bond to tooth, releases fluoride long-term.
- **Disadvantages:** Lower retention, higher wear rate, opaque appearance.
- **Best use:** Partially erupted teeth, patients with poor cooperation, primary molars [10].

3.3 Resin-Modified Glass Ionomers (RMGI)

- **Composition:** GI with small amount of resin monomer (e.g., HEMA).
- **Setting:** Dual-cure (light + acid-base).
- **Advantages:** Improved retention and strength over conventional GI, still releases fluoride.

- **Disadvantages:** More expensive than GI, still less wear-resistant than RBS.

3.4 Polyacid-Modified Resin (Compomer)

- **Composition:** Resin matrix with acidic monomers and glass fillers.
- **Setting:** Light-cured.
- **Advantages:** Better aesthetic and handling than GI, fluoride release.
- **Disadvantages:** Lower fluoride release than GI, retention similar to RBS.

3.5 Colour Variations

- **Clear:** Aesthetic but difficult to see during application.
- **Opaque/White:** Easy to visualise, aids in retention assessment.
- **Tinted (e.g., pink, yellow):** Useful for distinguishing sealant from tooth structure.

4. Recent Guidelines from the American Academy of Pediatric Dentistry (AAPD)

The AAPD, in collaboration with the American Dental Association (ADA), published an evidence-based clinical practice guideline for pit-and-fissure sealants in 2016, which remains the cornerstone of current best practice [11]. A summary of its key findings and recommendations is presented below.

4.1 Summary of Key Evidence

A systematic review of randomised controlled trials formed the basis of the guideline. Key quantitative findings are summarised in the table below.

Clinical Question	Key Finding (2–3-year follow-up)	Statistical Significance	Certainty of Evidence
Sealants vs. No Sealants (on sound or non-cavitated surfaces)	Caries incidence reduced by 76%	Significant	Moderate
Sealants vs. Fluoride Varnish (on sound surfaces)	Caries incidence reduced by 73%	Significant	Low
Sealants vs. Fluoride Varnish (on sound/non-cavitated surfaces)	Caries incidence reduced by 34%	Not significant	Low
GI vs. Resin-Based Sealants (on sound surfaces)	No statistically significant difference in caries incidence	Not significant	Very low
GI vs. Resin-Modified GI (on sound surfaces)	No statistically significant difference in caries incidence	Not significant	Very low

4.2 Key Recommendations

Based on this evidence, the guideline panel formulated the following recommendations for clinical practice [11]:

1. **For Preventing Caries:** The panel strongly recommends the use of sealants compared with no sealants on the occlusal surfaces of primary and permanent molars in children and adolescents with sound occlusal surfaces or non-cavitated carious lesions. This strong recommendation is supported by moderate-

quality evidence showing a 76% reduction in caries incidence over 2-3 years.

2. **Therapeutic Arrest of Lesions:** Sealants are recommended to minimize the progression of non-cavitated (initial) occlusal carious lesions.
3. **Comparative Effectiveness vs. Fluoride Varnish:** The panel conditionally recommends the use of sealants compared with fluoride varnish on the occlusal surfaces of primary and permanent molars in children and adolescents. This conditional recommendation reflects low-quality evidence suggesting

sealants may offer superior protection on sound surfaces, though the benefit on surfaces with existing non-cavitated lesions was not statistically significant.

4. **Choice of Material:** Based on available limited evidence, the panel was unable to provide specific recommendations on the relative merits of one type of sealant material over another.
5. **Adverse Events:** No significant adverse events associated with the use of pit-and-fissure sealants were identified in the reviewed literature.

4.3 Under-Utilization of Sealants

Despite the strong evidence, the guideline highlights that sealants remain underused [11]. The panel encourages clinicians to re-orient their efforts toward increasing the use of sealants on the occlusal surfaces of primary and permanent molars in children and adolescents [9]. A survey by the National Health and Nutrition Examination Survey (NHANES) found that while 41% of children aged 9-11 years had at least one dental sealant, this figure dropped to 36% in states with lower school-based sealant programme coverage [12]. These findings underscore the need for broader implementation of preventive strategies [11].

5. Best Practice: Clinical Procedure for Resin-Based Sealant

The following steps reflect the current best practice as recommended by the American Dental Association and European Academy of Paediatric Dentistry [6,11].

1. **Prophylaxis:** Clean the occlusal surface using a bristle brush with pumice or a non-fluoridated paste. Avoid fluoride-containing pastes immediately before etching (may reduce etch effectiveness).
2. **Isolation:** Isolate the tooth with a rubber dam or cotton rolls with a saliva ejector. Moisture control is critical saliva contamination is the leading cause of sealant failure.
3. **Etching:** Apply 35–37% phosphoric acid gel to the occlusal surface for 15–30 seconds (primary teeth: 30–60 seconds due to prismatic enamel).
4. **Rinsing & Drying:** Rinse thoroughly for 10–15 seconds. Dry with oil-free compressed air for 5 seconds. The etched enamel should appear **frosty white**; if not, re-etch.
5. **Sealant Application:** Apply the liquid sealant using a microbrush or explorer tip. Ensure complete penetration into all pits and fissures. Avoid air bubbles.
6. **Light Curing:** Cure according to manufacturer's instructions (typically 20–40 seconds per tooth). Use a light intensity >300 mW/cm².
7. **Evaluation:** Check for complete coverage, voids, and occlusal interferences. Remove excess with a probe or finishing bur. Evaluate

retention using an explorer; a retained sealant shows no marginal gap.

For glass ionomer sealants, the procedure differs: no etching is required, but the surface should be conditioned with polyacrylic acid. The material is pressed into fissures and allowed to set chemically.

6. Benefits and Efficacy

6.1 Caries Prevention

A landmark Cochrane systematic review [13] found that, in children and adolescents, resin-based sealants reduced caries incidence by 86% at 12 months and 57% at 48–54 months compared to no sealant. When compared to fluoride varnish, sealants were 40% more effective at preventing occlusal caries [14].

6.2 Arrest of Non-Cavitated Lesions

Sealing over early enamel lesions (white spots) halts demineralization by depriving bacteria of fermentable carbohydrates. A 2024 systematic review [15] concluded that sealants are as effective as invasive restorations for ICDAS 1–2 lesions, with the advantage of being minimally invasive.

6.3 Long-Term Retention and Cost-Effectiveness

Partial or complete sealant retention is still protective. Even sealants that have partially lost material provide some benefit as long as the fissure remains blocked. The cost of placing sealants is substantially lower than that of treating occlusal caries (e.g., composite restorations), making them highly cost-effective in high-risk populations [16]. The AAPD guidelines highlight that sealing permanent molars reduces costs to the health system by delaying and preventing the need for invasive restorative treatment, particularly in patients classified as having an “elevated caries risk” [17].

6.4 Additional Benefits

- **Non-invasive:** No local anaesthesia or tooth preparation required.
- **Rapid application:** 2–5 minutes per tooth.
- **Patient acceptance:** Painless and well-tolerated by children.

7. Follow-up and Maintenance

Sealants should be re-evaluated at each recall visit (e.g., every 6–12 months). The AAPD recommends that sealants be monitored and may require reapplication to remain effective over time. The following classification is used:

- **Complete retention:** Fully present.
- **Partial retention:** Some loss but fissure still sealed.
- **Complete loss:** No sealant visible reapply if indicated.

8. CONCLUSIONS

Pit and fissure sealants are a safe, effective, and evidence-based intervention for preventing and arresting occlusal caries. Resin-based sealants offer the highest retention, while glass ionomers provide advantages in moisture-prone situations. Adherence to proper clinical technique especially isolation and etching is the single most important factor for success. Regular recall and reapplication as needed ensure long-term caries protection. Recent evidence-based guidelines from the AAPD strongly recommend the use of sealants for caries prevention in children and adolescents, although they note the continued underutilization of this effective intervention.

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