



Review Article

POST-OPERATIVE SENSITIVITY AFTER COMPOSITE RESTORATIONS: A REVIEW STUDY

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Received : 10/12/2025
Received in revised form : 17/01/2026
Accepted : 05/02/2026

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DOI: 10.70034/ijmedph.2026.1.330

Source of Support: Nil,

Conflict of Interest: None declared

Int J Med Pub Health

2026; 16 (1); 1895-1900

ABSTRACT

Post-operative sensitivity (POS) following resin-based composite restorations remains a frequent patient-reported complication and a common reason for early postoperative review. This review synthesises current evidence on the prevalence, biological mechanisms, material- and technique-related contributors, diagnostic considerations, and prevention strategies associated with POS after posterior and occlusal composite restorations. The pathophysiology is best explained by the hydrodynamic mechanism, in which rapid dentinal tubule fluid movement stimulates pulpal mechanoreceptors, producing short, sharp pain to cold, air, osmotic stimuli, or mechanical loading. Clinically, POS is typically transient and declines within days to weeks; however, persistent or worsening symptoms may indicate occlusal trauma, marginal leakage, interfacial failure, crack-related pain, or progressive pulpal inflammation. Polymerization shrinkage and contraction stress can compromise interfacial integrity, particularly in high C-factor cavities, contributing to gap formation and microleakage that amplify dentin permeability. Evidence indicates that broad adhesive strategy (etch and rinse versus self-etch versus universal) does not consistently predict POS when trials are pooled, highlighting the overriding importance of technique sensitivity, including moisture control, solvent evaporation, adhesive polymerization, and adequate light delivery. Placement approach (incremental versus bulk-fill) influences depth of cure and stress distribution, with studies commonly reporting early sensitivity that diminishes over time when protocols are followed. Liners such as resin-modified glass ionomer may reduce symptoms in selected deep preparations by improving dentin protection and sealing, though routine use is not universally indicated. A structured diagnostic pathway—characterizing pain, checking occlusion, testing pulpal status, and evaluating margins—supports conservative management for improving cases and targeted intervention for correctable causes. Overall, POS is best minimized through risk assessment, meticulous dentin sealing, disciplined curing and placement protocols, and careful occlusal adjustment.

Keywords: Composite resin; postoperative sensitivity; dentin hypersensitivity; adhesive systems; polymerization shrinkage.

INTRODUCTION

Post-operative sensitivity (POS) following resin-based composite restorations is one of the most common early complications reported by patients and one of the most frequent drivers of unscheduled follow-up appointments in restorative practice. Clinically, it is most often described as a sharp, short-lasting pain in response to cold, sweet stimuli, or evaporative air, and less commonly as discomfort on mastication or pain on release after biting. Although many cases resolve spontaneously within days to weeks, POS can negatively affect patient satisfaction and confidence in the clinician, and it may also represent an early warning sign of an underlying problem such as occlusal trauma, interfacial leakage, or pulpal inflammation. Large practice-based datasets emphasize two important realities about POS. First, many teeth already exhibit preoperative sensitivity due to caries activity, dentin exposure, microcracks, or occlusal overload; therefore, postoperative symptoms are not always attributable solely to restorative procedures. Second, POS can occur even when restorations appear clinically acceptable, suggesting a multifactorial etiology that includes patient factors, tooth factors, and technique-related variables. In the PEARL Network observational study of Class I resin-based composite restorations, postoperative hypersensitivity was reported at multiple time points and was not exclusively limited to teeth with baseline hypersensitivity, reinforcing that both preexisting biologic variability and operative factors contribute to symptom development.^[1] From a mechanistic perspective, POS after composite placement is commonly linked to events at the dentin–adhesive–composite interface and the response of the pulp–dentin complex to external stimuli. Composite resins undergo polymerization shrinkage during curing, and when the composite is bonded to cavity walls, shrinkage is partially restrained, generating contraction stress. This stress can challenge the integrity of the adhesive interface, contribute to marginal gap formation, or exacerbate nanoleakage and microleakage, particularly when the cavity configuration factor (C-factor) is high. Reviews of contraction stress management underscore that stress magnitude is influenced by composite formulation, elastic modulus, cavity design, bonded/unbonded surface ratio, and curing dynamics, and that stress-related interfacial defects are a plausible pathway to symptoms in susceptible teeth.^[2] A complementary review of shrinkage stress during resin-composite application similarly highlights that the interface may behave as the “weakest link” under contraction and functional loading, with clinical consequences ranging from marginal staining and debonding to sensitivity in the early postoperative period.^[3] Biologically, the most widely accepted explanation for sensitivity symptoms is the hydrodynamic concept: rapid movement of fluid within dentinal tubules can stimulate mechanoreceptors in the pulp

and inner dentin and be perceived as sharp pain. The hydrodynamic theory explains why cold, evaporative air, osmotic changes, and mechanical loading can provoke similar symptoms, and why incomplete dentin sealing can amplify sensitivity.^[4] Operative procedures that increase dentin permeability—through tubule exposure, smear layer modification/removal, over-drying, or inadequate resin infiltration—can heighten fluid movement and thus symptom risk. Importantly, the patient’s baseline pulp status and remaining dentin thickness act as biologic “buffers”; a shallow-to-moderate preparation with a healthy pulp may tolerate the same restorative stresses that provoke symptoms in a deep lesion with minimal residual dentin.

Given the centrality of dentin sealing, adhesive strategy has been studied extensively.

Clinicians often expect that a particular approach (etch-and-rinse vs self-etch, selective enamel etching, or universal adhesives in different modes) will reliably reduce POS. However, when randomized clinical trials are pooled, the broad adhesive strategy alone does not appear to be a consistent determinant of POS. In a systematic review and meta-analysis comparing self-etch and etch-and-rinse adhesives for posterior composite restorations, no overall difference was found in risk or intensity of postoperative sensitivity when appropriately conducted trials were combined, suggesting that execution quality—moisture control, adequate infiltration, solvent evaporation, and thorough polymerization—may be more decisive than the category of adhesive chosen.^[5] This aligns with the clinical impression that POS is often an outcome of multiple small deviations (isolation challenges, dentin condition, curing angle, incremental technique, finishing/occlusion) rather than a single “wrong material.”

Finally, POS should be treated as a diagnostic entity rather than merely a nuisance. Symptoms after restoration can reflect reversible pulpal irritation, high occlusion (particularly on excursions), exposed dentin margins, marginal leakage, crack-related pain, or a pre-existing pulpal condition that progressed independently of the restoration. Clinical trial evidence shows that different adhesives can yield similar postoperative sensitivity outcomes in controlled settings, which further supports the need for systematic assessment and targeted management rather than reflexive replacement of restorations.^[6]

Epidemiology and clinical pattern of post-operative sensitivity

POS is most commonly reported within the first 24–72 hours after restoration and typically declines over the first week, with a smaller subset persisting beyond one month. The symptom pattern is clinically useful: short, sharp pain to cold that resolves quickly is more consistent with dentin-mediated hypersensitivity, whereas spontaneous pain, prolonged lingering response to cold, or escalating nocturnal pain raises concern for irreversible pulpitis. A key clinical insight is that POS is not uniform

across patients; it is shaped by baseline sensitivity, caries depth, and preparation variables, and therefore must be interpreted in the context of the tooth's preoperative status. Practice-based trials and observational datasets have demonstrated that postoperative symptoms may occur even under routine care conditions with experienced clinicians. The PEARL Network has repeatedly highlighted that appreciable sensitivity can be detected at early follow-ups and that some teeth develop symptoms despite low baseline sensitivity, implying that operative and restorative variables contribute meaningfully to the outcome.^[7] Importantly, patient-reported outcomes (VAS scales or structured questionnaires) often detect symptoms that are not obvious during a brief clinical evaluation. Temporal resolution is a core characteristic of benign POS. Many cases show meaningful improvement by one week and resolution by one month, particularly when occlusal discrepancies and marginal finishing issues are absent. Conversely, symptoms that persist or worsen should prompt reassessment for occlusal trauma, marginal leakage, or pulpal pathology. The clinician's role is to distinguish "expected" transient sensitivity from early signs of failure or disease progression, and to educate patients appropriately while maintaining a low threshold for review when pain characteristics suggest pulpal involvement.

Pulp-dentin complex and the tubule-fluid mechanism

The pulp-dentin complex is a biologically active unit that responds to operative trauma, bacterial challenge, and restorative interface quality. Dentin contains tubules that transmit fluid movement and can communicate external stimuli to pulpal nerves. When dentin is exposed or insufficiently sealed, thermal and osmotic stimuli can induce fluid shifts that provoke pain. While the hydrodynamic mechanism is a biologic model, the clinical implication is practical: the more permeable the dentin, and the more imperfect the seal, the higher the probability that a patient experiences POS during the early postoperative period. Restorative procedures influence dentin permeability through smear layer formation/removal, acid conditioning, adhesive infiltration, and polymerization quality. Even when the smear layer is retained, it may be variably permeable and can be disrupted by functional stresses, allowing microleakage and pulpal irritation. Conversely, an effective hybrid layer and well-polymerized adhesive can reduce dentin permeability and dampen sensitivity. Clinical evidence supports that interventions aimed at improving the dentin seal can reduce symptoms in specific contexts. For example, practice-based research has evaluated liner strategies intended to reduce sensitivity and found measurable differences in patient-reported symptoms under certain conditions.^[8]

Polymerization shrinkage stress and interfacial gap formation

Polymerization shrinkage remains a central material phenomenon in composite restorations. As composite

cures, volumetric contraction occurs; when bonding restrains contraction, stress develops at the tooth-restoration interface. High stress can contribute to marginal gap formation, debonding at the adhesive interface, or microcrack propagation in enamel margins. These defects can permit microleakage, thermal fluid movement in tubules, and postoperative symptoms in the early healing period. Shrinkage stress is not solely dictated by "shrinkage percentage." It is influenced by modulus development (how quickly stiffness rises during curing), cavity configuration (C-factor), thickness of increments, curing protocol, and the compliance of the adhesive layer. In clinical settings, deep Class I and Class II restorations are at particular risk due to high bonded surface area and limited unbonded surface for stress relief.

Bulk placement may magnify these effects if depth of cure is marginal or stress is concentrated. Clinical trials that compare restorative approaches indirectly support the clinical relevance of these mechanisms. Differences in symptom profiles across restorative materials and placement approaches are often most evident early, when stress-related defects and tubule exposure are most likely to influence symptoms. For example, bulk-fill versus conventional approaches have been assessed with postoperative sensitivity as an endpoint, showing that early sensitivity can occur but may decline substantially with time.^[9]

Adhesive strategy and dentin sealing effectiveness

Although broad adhesive categories (etch-and-rinse vs self-etch vs universal) do not consistently predict POS in meta-analyses, adhesive strategy still matters because it shapes how the smear layer is managed, how tubules are sealed, and how tolerant the system is to moisture variability. Etch-and-rinse adhesives can increase dentin permeability if resin infiltration is incomplete or if dentin is over-dried or over-wet, whereas self-etch approaches may retain smear plugs and reduce immediate permeability—but may also be more sensitive to substrate variability and solvent management. The practical determinant is whether the adhesive forms a stable and continuous seal. Poor solvent evaporation, inadequate air thinning, and inadequate curing can leave a permeable adhesive layer and contribute to postoperative symptoms. Conversely, careful execution—active application/scrubbing, controlled air thinning, and adequate light delivery—improves polymerization and sealing. Clinical trials comparing total-etch and universal adhesives have reported no statistically significant difference in postoperative hypersensitivity when procedures are standardized and isolation is controlled, suggesting that technique quality can neutralize expected differences between systems.^[10] In addition, systematic syntheses of adhesive systems and clinical outcomes have found limited evidence that the adhesive system alone determines sensitivity outcomes, reinforcing that the clinical pathway should prioritize procedural control over "brand switching."^[11]

Tooth- and preparation-related risk factors

Tooth factors that increase POS risk include deeper caries (less remaining dentin thickness), preoperative hypersensitivity, cracks or craze lines, and heavy occlusal load. Preparation variables include cavity depth and volume, proximity to the pulp, dentin caries activity, and the presence of sclerotic or altered dentin substrate. Deeper lesions may already involve inflammatory mediators within the pulp, making the tooth more reactive to thermal and mechanical stimuli after restoration. The PEARL Network has documented relationships between baseline sensitivity and postoperative outcomes in Class I restorations, suggesting that preoperative symptoms are an important predictor that should be captured systematically before intervention.^[1] Clinically, this supports using standardized pulp testing (cold test response and lingering time, percussion, bite test when indicated) and documenting preoperative sensitivity scores when feasible. This helps interpret postoperative complaints and reduces diagnostic uncertainty. Preparation-related trauma also matters. Excessive heat from instrumentation, dehydration from prolonged air drying, and aggressive removal of dentin beyond infected tissue can increase pulpal irritation. Rubber dam isolation and controlled dentin conditioning help reduce moisture variability and bacterial contamination, but they do not eliminate the biologic effects of lesion depth. Therefore, risk stratification should be part of preoperative planning: deep lesions may benefit from conservative caries removal strategies and careful postoperative monitoring.

Bulk-fill versus incremental placement and sensitivity outcomes

Placement technique influences curing, stress distribution, and adaptation. Incremental layering (typically ≤ 2 mm) aims to improve depth of cure and reduce polymerization stress by lowering the C-factor for each increment and allowing some stress relaxation. Bulk-fill composites, designed for deeper increments, reduce clinical time and technique sensitivity but require careful light delivery and adherence to manufacturer instructions to achieve adequate polymerization. Clinical evidence indicates that POS can occur with both approaches and is often most prominent early. Studies comparing bulk-fill approaches with conventional incremental techniques commonly report that sensitivity peaks early and diminishes with time, suggesting that early interfacial changes or transient pulpal irritation may resolve as the pulp recovers and tubule fluid dynamics stabilize. In a randomized clinical evaluation comparing bulk-fill resin composite with a nano resin composite approach, postoperative sensitivity was measured as a key endpoint, supporting the concept that early symptoms are detectable but not necessarily persistent when restorations are otherwise clinically acceptable.^[9] Another randomized clinical trial comparing bulk-fill forms has similarly used postoperative sensitivity as a clinical endpoint and emphasizes that technique

standardization and follow-up timing strongly influence perceived differences.^[12]

Liners, flowable “stress-absorbing” layers, and dentin protection

Liners and low-modulus intermediate layers have been proposed to reduce POS by improving adaptation, reducing microleakage, providing a more compliant stress-absorbing interface, and/or reducing dentin permeability. Resin-modified glass ionomer (RMGI) liners are also theorized to provide chemical bonding and fluoride release, though the clinical significance of fluoride release for immediate sensitivity is uncertain. Practice-based clinical research provides some support that liner use can reduce postoperative hypersensitivity in selected scenarios. In the PEARL Network study evaluating an RMGI liner under posterior restorations, liner use was assessed as an intervention for sensitivity reduction, reflecting a real-world question faced by clinicians.^[8] Separately, randomized clinical evaluation of glass-ionomer cement lining in resin composite restorations has also investigated postoperative sensitivity outcomes, supporting the hypothesis that a liner can influence symptoms, particularly in situations with deeper dentin exposure.^[13] However, liner selection should be rational and not routine. Overthick liners can compromise composite thickness and mechanical properties, and they may create additional interfaces that are vulnerable to debonding if handled poorly. Clinically, liners are most defensible when residual dentin thickness is limited, when dentin permeability is expected to be high, or when the clinician anticipates difficulty in achieving an ideal dentin seal due to moisture control or access challenges.

Finishing, polishing, and occlusal adjustment as determinants of symptoms

Not all “postoperative sensitivity” is tubule-mediated. Occlusal trauma is a common, underrecognized cause of postoperative pain after posterior composites. High occlusion can produce pain on biting or on release and may mimic cracked tooth symptoms. Because composite restorations can slightly alter occlusal anatomy and contact timing, careful occlusal verification in maximum intercuspation and in excursions is essential. Early postoperative pain that is primarily mechanical (biting discomfort) should prompt occlusal evaluation before assuming pulpal pathology or marginal leakage. Finishing and polishing can also influence sensitivity. Over-finishing near cervical areas may expose dentin or thin enamel margins, creating a pathway for thermal stimulation. Inadequate removal of oxygen-inhibited layers at margins may affect marginal integrity and plaque retention, indirectly influencing gingival inflammation and perceived discomfort. While these factors are more related to longer-term comfort than immediate sensitivity, they can interact with early symptoms. Clinical research suggests that seemingly minor procedural variables can influence outcomes. Trials examining adhesive handling (including air

thinning and curing protocols) reflect the broader point that interface quality and finishing steps affect postoperative experiences.^[14]

Diagnostic approach and management pathway for symptomatic teeth

A structured diagnostic pathway reduces unnecessary restoration replacement and improves patient outcomes. The clinician should first characterize the pain: stimulus type (cold, sweet, biting), duration (seconds vs lingering), spontaneity, timing (immediate vs delayed onset), and whether the pain is improving. Next, assess occlusion (including excursions), evaluate margins and contact areas, and perform pulp sensibility testing (cold test response and lingering time) with comparison to adjacent and contralateral teeth. Radiographs may be warranted to evaluate proximity to pulp, recurrent caries, or periapical change. Management is typically staged. If pain is mild, stimulus-provoked, short-lasting, and improving, reassurance and monitoring are reasonable, with reinforcement of avoiding extreme thermal stimuli and allowing time for pulpal recovery. If pain is biting-related, occlusal adjustment is often the primary intervention. If marginal defects, open contacts, or signs of leakage exist, targeted repair or replacement may be indicated. Persistent or worsening symptoms, spontaneous pain, or lingering cold response should prompt consideration of pulpal pathology and possible endodontic assessment. Clinical studies show that different adhesive systems may produce similar sensitivity outcomes, emphasizing that management should be diagnosis-driven rather than material-driven.^[6] Similarly, trials documenting postoperative symptom trajectories reinforce that early sensitivity can diminish without aggressive intervention, provided no correctable occlusal or marginal defect is present.^[9]

Prevention checklist and future directions

Because POS is multifactorial, prevention should be implemented as a “bundle” of controllable steps:

Preoperative risk assessment: document baseline sensitivity, evaluate caries depth radiographically, and identify crack risk or heavy occlusion.^[1]

Isolation and substrate control: rubber dam when feasible; avoid dentin desiccation; maintain controlled moisture conditions during bonding.

Adhesive execution: active application, thorough solvent evaporation, adequate air thinning, and adequate curing energy at correct angulation.^[10,14]

Placement technique: incremental layering when appropriate; when using bulk-fill, follow depth and curing recommendations strictly and ensure light output is adequate.^[12]

Selective liner use: consider RMGI liner in deeper lesions or where dentin permeability is high and sealing is challenging.^[8,13]

Finishing and occlusion: verify static and dynamic occlusion, correct high points, and avoid iatrogenic dentin exposure during finishing.

Future directions include materials designed to reduce shrinkage stress and improve interfacial

stability, more robust chairside methods to quantify delivered curing energy, and better predictive models integrating baseline sensitivity, lesion depth, and restorative approach to personalize technique selection. Clinical trials continue to evaluate newer adhesive and composite systems with sensitivity as a key patient-centred end point, including comparisons of self-adhesive bulk-fill approaches and universal adhesive modes.^[15,16]

CONCLUSION

Post-operative sensitivity after composite restorations is a multifactorial, predominantly early and self-limiting outcome driven by dentin permeability, interfacial integrity, polymerization shrinkage stress, and occlusal factors. Evidence indicates that adhesive “category” alone does not consistently predict sensitivity; rather, meticulous technique—effective dentin sealing, correct curing, appropriate placement strategy, and careful finishing/occlusal adjustment—best reduces risk. Baseline tooth status and lesion depth remain key predictors and should guide risk stratification and follow-up. A structured diagnostic pathway allows timely correction of reversible causes while identifying cases that require pulpal assessment.

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