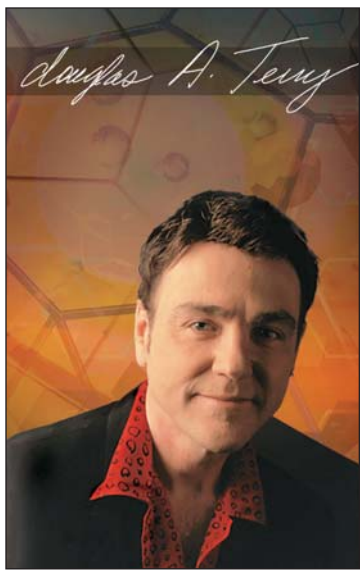
fundamentals of adhesion

Dentin Hypersensitivity: Part II

Douglas A. Terry, DDS*

Dentin sensitivity is a challenge faced by the patient and clinician after many restorative procedures. Reports of the incidence, severity, and duration of postoperative thermal sensitivity are varied.[1,2] *Postrestorative* sensitivity can be related to preparation trauma, microleakage of the restoration, toxicity of the restorative material (ie, composite resin), and a host of other factors.[3,4] Furthermore, the sensitivity responses of teeth receiving initial restorations can be quite different from those with replacements, since secondary/tertiary dentin formation may have formed during the latter, which can dramatically change dentin permeability.[5] Traditionally, varnishes, liners, and bases placed under definitive restorations were the restorative approach to reducing sensitivity and providing pulp protection. One clinical study, however, indicated that the incidence of postoperative sensitivity was significantly higher when one of the pulp protection procedures was used compared to control restorations that received no protection.[6] The two current adhesive strategies (eg, total-etch, self-etch) provide a layer of polymerized resin that seals the dentinal tubules and allows internal adaptation for stress relief at the restorative interface while eliminating sensitivity.



Management of Adhesive Postrestorative Sensitivity

In general, management and prevention of postrestorative sensitivity begins at the diagnosis and treatment-planning phase. Prior to restorative treatment, an appropriate diagnosis should be made for any tooth that exhibits dentin hypersensitivity. Conditions that should be considered in the differential diagnosis include the following: dental caries, fractured restorations, chipped teeth, symptomatic teeth with superficial or deep cracks in them, postrestorative sensitivity, and pulpal abscesses.[7] Diagnostic evaluation of the dental pulp status through accurate timing of the interval between cold stimulation and pulpal reaction (pain) and duration of the pain can provide changes in pulpal health by comparing the thermal responses between sensitive and nonsensitive teeth. This differential diagnosis can provide a profile for which teeth are at risk for irreversible pulpal degeneration and which may benefit from palliative treatment.[8] The use of a zinc oxide-eugenol (ZOE) temporary cement for teeth that are sensitive preoperatively has been suggested as a popular palliative treatment. Sensitivity may dissipate because the bacterial growth on the cavity walls is eliminated, drainage of outward fluid is established because ZOE does not provide a hermetic seal, and nerve excitability is reduced by free eugenol blocking impulse transmission.[9] A lack of sensitivity or clinical symptoms does not signify a healthy pulp, however, and radiographic evaluation is required before the final restorative procedure is initiated and completed.[10]

Consideration Factors

Although the hydrodynamic link is the mechanism responsible for postrestorative sensitivity in direct and indirect bonded restorations, there are different factors when considering its etiology in each restorative techniques. Although the effects of wall stresses on postrestorative sensitivity are unknown,[11] the sensitivity associated with posterior composites appears to be influenced by the configuration factor (ie, C-factor) for the dental restoration. This represents the ratio between the bonded to unbonded surface walls of a restoration and indicates the shrinkage stress that can occur during polymerization that can result in increased gap formation. This would suggest that restorations with less free surfaces (ie, Class

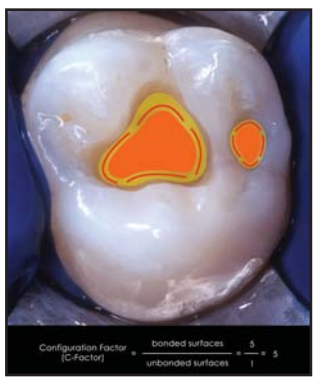


Figure 1. Postoperative sensitivity from a fluid-filled microgap is more probable with an occlusal composite restoration because of the higher configuration factor.[1]

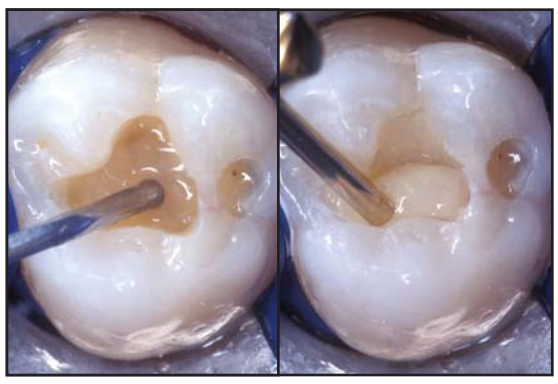


Figure 2A. Flowable composites can be used to absorb shrinkage stresses. 2B. Oblique layering can also reduce sensitivity.

Figure 3. Prehybridization procedures prevent the causes of postrestorative sensitivity after preparation, provisionalization, and cementation.

I) have the potential for more postrestorative sensitivity than restorations with more free surfaces (ie, Class IV) (Figure 1).[1] In direct bonding, there are several methods to prevent this destructive shrinkage stress during composite resin placement including the application of liners and bases that act as shock absorbers and/or reduce cavity volume, selective bonding in appropriate cavity configurations, reducing light intensity from curing units, and utilizing a combination of selective bonding and incremental layering of small increments of composite resins (Figure 2).[12,13]

There are several factors that can influence teeth with indirect adhesive restorations to have postrestorative sensitivity. Generally, the diagnosis for bonded indirect restorations requires a combination of the following clinical conditions: fracture, caries, and/or previous restorations.[1] The consideration factors for the etiology of postrestorative sensitivity in these restorations typically involve the period of time between preparation and cementation. The preparation design for indirect adhesive restorations usually demands a greater amount of tooth structure removal and thus the potential for more exposed and open dentinal tubules, which will increase fluid flow and the risk of sensitivity. Furthermore, frictional heat from tooth preparation and increased tooth dessication can promote increased tooth sensitivity.[1] Since the clinical protocol for most indirect restorative techniques utilizes two appointments, there is a potential for microleakage of the provisional between preparation and completion of the restoration. This can result in microbial invasion of the open dentinal tubules and may contribute to dentin hypersensitivity as well as to inflammatory processes in the underlying pulp tissue. During adhesive cementation, the hydraulic intratubular loading pressure and the irritating chemicals in the composite resin cement can also be responsible for pulpal sensitivity.[14]

Prehybridization is a clinical procedure that will eliminate these causes of postrestorative sensitivity after preparation, provisionalization, and cementation. This technique allows the development of a hybrid layer on vital teeth immediately after cavity preparation; this prevents microleakage by providing an acid-resistant envelope that seals the dentin and protects the pulp from mechanical trauma, thermal stimuli, and bacterial invasion.[15] This also prevents hypersensitivity during impression-making, provisional restoration fabrication, and cementation. Additional benefits include improved marginal and interfacial adaptation with reduced gap formation at the internal tooth-restorative interface, reduction of internal stress by relieving polymerization contraction stress, prevention of dessication of the dentin, and the possible improvement of the bond strength of resin cement to dentin with

certain provisional cements,[16] as well as the facilitating of the removal of provisional cement, and possible prevention of hydraulic intratubular loading pressure during cementation of restoration (Figure 3).

Guidelines for Clinical Success

Clinical success with any bonded restoration begins and ends at the restorative interface. Therefore, the prevention and elimination of postrestorative sensitivity for these restorations requires a proper adhesive protocol and a durable adhesive interface. In addition to the aforementioned consideration factors for bonded restorations, achieving an optimal and durable adhesive bond requires knowledge and experience of the adhesive bonding system and the manufacturer's suggestions for use, and the necessary condition of the substrate for each adhesive system. Furthermore, a durable interfacial adhesion between the tooth and biomaterial requires a clean surface of the substrate, a low contact angle that allows the adhesive to spread over the entire surface of the substrate, and optimal internal adaptation of the biomaterial to the substrate.[15] The following guidelines should be utilized with these consideration factors for the preparation and placement of adhesive restorations:

- Utilize dental dam isolation;
- Monitor tooth composition as dentin that has experienced microstructural modifications (ie, sclerotic dentin) presents challenges to consistent and predictable bonding;
- Understand and have a knowledge of the adhesive solvent (eg, water, ethanol, acetone) and how it controls the application technique and the necessary moisture content of the dentin;
- Monitor curing light power, since improperly cured composite has been shown to be damaging to pulp. The procedure requires an efficient curing unit with a minimum of 450 mW/cm^2;
- Preserve marginal integrity during finishing. Reduced and/or delayed finishing may help to preserve the marginal integrity. Avoid aggressive cutting of tooth structure and mutilation of margins; and
- Evaluate occlusion with patient in upright position, immediately and 24 hours postoperation.

Conclusion

The transition in terminology from postoperative to postrestorative sensitivity reflects the need for changes in philosophy of restorative treatment. Prevention and management of dentin hypersensitivity are concepts that have developed from a better understanding of the mechanism of dentinal pain and one's knowledge of adhesive systems and restorative materials and their interrelation with living tissue through improved operative techniques.

References

1. Swift EJ Jr. Causes, prevention and treatment of dentin hypersensitivity. Compend Contin Educ Dent 2004;25(2):95-106,109.
2. Wilson NHF, Wilson MA, Wastell DG, Smith GA. Performance of occlusion in butt-joint and bevel-edged preparations: Five years results. Dent Mater 1991;7(2):92-98.
3. Perdigao J, Anauate-Netto C, Carmo AR, et al. The effect of adhesive and flowable composite on postoperative sensitivity: 2-week results. Quintessence Int 2004;35(10):777-784.
4. Sjogren G, Bergman M, Johansson K. Piezoelectricity in dental materials, a conceivable cause of postrestorative sensitivity. Acta Odontol Scand 1992;50(5):313-319.
5. Pashley DH. Dynamics of the pulpo-dentin complex. Crit Rev Oral Biol Med 1996;7(2):104-133.
6. Unemori M, Matsuya Y, Akashi A, et al. Self-etching adhesives and postoperative sensitivity. Am J Dent 2004;17(3):191-195.
7. Wichgers TG, Emert RL. Dentin hypersensitivity. Gen Dent 1996;44(3):225-230.
8. Leffingwell CS 3rd, Meinberg TA, Wagner JG, et al. Pulp responses to precise thermal stimuli in dentin-sensitive teeth. J Endod 2004;30(6):384-387.
9. Brannstrom M. The cause of postrestorative sensitivity and its prevention. J Endod 1986;12(10):475-481.
10. Plant CG, Anderson RJ. The effect of cavity depth on the pulpal response to restorative materials. Br Dent J 1978;144(1):10-13.
11. Roberson TM, Heymann HO, Swift EJ. Sturdevant's art & science of operative dentistry. 4th ed. St. Louis, MO: Mosby 2001.
12. Lutz F, Krejci I, Barbakow F. Quality and durability of marginal adaptation in bonded composite restorations. Dent Mater 1991;7(2):107-113.
13. Feilzer AJ, Dooren LH, de Gee AJ, Davidson CL. Influence of light intensity on polymerization shrinkage and integrity of restoration-cavity interface. Eur J Oral Sci 1995;103(5):322-326.
14. Christensen GJ. Resin cements and postoperative sensitivity. J Am Dent Assoc 2000;131(8):1197-1199.
15. Nakabayashi N, Kojima K, Masuhara E. The promotion of adhesion by the infiltration of monomers into tooth substrates. J Biomed Mater Res 1982;16(3):265-273.
16. Paul SJ, Schärer P. Effect of provisional cements on the shear bond strength of various denting bonding agents. J Oral Rehabil 1997;24(6):433-438.
17. Anusavice KJ. Structure of matter and principles of adhesion. 10th ed. In: Phillips' Science of Dental Materials. Philadelphia,PA: W.B. Saunders Company, 1996.

Assistant Professor, Department of Restorative Dentistry and Biomaterials, University of Texas Health Science Center Dental Branch, Houston, TX; Faculty Member, University of California Center for Esthetic Dentistry, Los Angeles, CA; private practice, Institute of Esthetic and Restorative Dentistry, Houston, TX.