Joseph Sabbagh

Jean Claude Fahd and Robert J McConnell

Post-operative Sensitivity and Posterior Composite Resin Restorations: A Review

Abstract: With an increasing use of posterior composite resin restorations, the incidence of post-operative sensitivity has become an everyday clinical problem. The aim of this paper is to identify the possible causes of post-operative sensitivity and explore how it can be avoided and treated.

CPD/Clinical Relevance: This paper addresses the different causes responsible for post-operative sensitivity following composite placement. Also the management of this situation is discussed.

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In many countries the use of amalgam to restore posterior teeth is declining, with composite resin replacing it as the material of choice.[1] As composite resin replaces amalgam as the material of choice for restoring posterior teeth, the incidence of post-operative sensitivity has increased, with the highest incidence in posterior composite restorations.[2] The more complex the restorative procedure required for the placement of a composite resin restoration, including etching of enamel and dentine and the application of acidic adhesive monomers, may be related to the higher incidence of pain.

Post-operative sensitivity can be difficult to manage. Patients often complain of sensitivity at different levels and intensities, often with no evidence of failure of the restoration.[3]

Brännström first explained the physiology of pulpal pain in 1962,[4] and in 1963 he described in his thesis the hydrodynamic fluid movement theory.[5] Pain results from indirect innervations caused by dentinal fluid movement in the tubules, which then stimulates mechanoreceptors near the odontoblast processes. The response of the pulpal nerves is proportional to the fluid flow generated. The A-delta fibres respond to stimulation of dentinal tubules (eg airblast), whereas pulpal C-fibres respond to bradykinin or capsaicin. This study has implicated pulpal A-delta fibres in mediating dentinal sensitivity and pulpal C-afferent fibres in mediating pulpal inflammation.

Factors which may be responsible for sensitivity following the placement of composite restorations include:

- The remaining dentine thickness;
- The tubule diameter and the sealing of the tubules following etching; and
- The overall pulp status of the tooth.

Other factors relate to the operator and the restorative procedure.

Langeland concluded that dentine exposed during the preparation of cavities or crowns should be covered immediately with a non-irritating material to seal the tubules and thus prevent microleakage.[6]

This paper will address the possible aetiological factors and outline prevention and management modalities to decrease the occurrence of hypersensitivity.

Types and causes of tooth sensitivity

There are three types of tooth sensitivity:

1. Physiological;
2. Pathological; and
3. Iatrogenic.

A sound tooth shows normal or physiological sensitivity when exposed to cold or hot stimuli.[7]

Pathology, such as caries, cracks, erosion or gingival recession may cause an exaggerated response to thermal, chemical or mechanical stimuli.

Joseph Sabbagh, DDS, MSc, PhD, FICD, Professor, Restorative and Aesthetic Dentistry Department, Lebanese University, Beirut, Lebanon, **Jean Claude Fahd,** DDS, DESS, Former Chairperson, Restorative and Aesthetic Dentistry Department, Lebanese University, Beirut, Lebanon and **Robert J McConnell,** BDS, FFD, PhD, Emeritus Professor, Restorative Dentistry, University Dental School and Hospital, Wilton, Cork, Ireland.

Iatrogenic sensitivity is caused by procedures carried out by the dentist or dental healthcare worker. Examples include periodontal procedures and removal and replacement of tooth structure during intra-coronal and extra-coronal restorations.

Iatrogenic factors

Cavity preparation

Several studies have demonstrated that a temperature increase during cavity preparation can lead to irreversible damage of dental tissues. An increase of over 5 °C may cause pulp necrosis.[8] While using cutting burs during cavity preparation, abundant water irrigation should be used in order to decrease pulpal heating. It is preferable to use a turbine with four water holes for irrigation instead of a single hole directed towards the bur. This will ensure thorough and abundant irrigation. During preparation, regular changing of burs and the use of light pressure will reduce heat and pressure.

During caries excavation, all efforts must be made to minimize pulp overheating and vibrations, by using manual caries excavation with a sharp excavator or using a slow running round steel bur with light pressure.

Post-operative sensitivity related to the adhesive system

According to the manufacturers, self-etch adhesives (known also as 6th, 7th and 8th generation) cause less sensitivity than total-etch systems. Many studies have been conducted and contradictory results have been reported. Some studies did not observe any difference in post-operative sensitivity and marginal discoloration when using self-etch or total-etch adhesives systems.[9] Others concluded that, in deep cavities, the use of self-etching bonding systems was effective in reducing post-operative sensitivity compared to total-etch adhesive systems.[10,11]

A further study[12] used randomized clinical trials that compared the clinical effectiveness of the self-etch technique with the etch and rinse technique used for direct resin composite restorations in permanent teeth of adult patients. The risk/intensity of post-operative sensitivity was the primary outcome measure. They concluded that the type of adhesive or the technique used for posterior resin composite restorations did not influence the risk and intensity of post-operative sensitivity.

Swift *et al* compared the incidence of post-operative sensitivity to the type of adhesive system, total-etch versus self-etch.[13] They reported that, during the first week after placement of Class I posterior composite restorations, 23% of the patients experienced post-operative sensitivity following the use of either total-etch (*Optibond Solo Plus*, Kerr, Orange, USA) or self-etch (*Xenon III*, Dentsply, Konstanz, Germany) adhesive. But sensitivity decreased greatly with time, and the differences between the two groups was not statistically significant. Thus, the incidence of post-operative sensitivity may not be influenced by the bonding system.[9 10 11]

Post-operative sensitivity and the use of desensitizers

The role of the adhesive layer is to seal the dentine tubules exposed by the etchant and to bond and retain resin composite to the walls of the cavity. Multiple layers of bonding agents do not prevent or decrease sensitivity. The shear bond strength of some adhesives may be negatively influenced by multiple layers of bonding agent, although with the one-step self-etching system, the application of consecutive coats can improve bond strength.[10 11]

Studies have been carried out to investigate the effectiveness of desensitizing agent on post-operative sensitivity.[14] Many have found that the application of a desensitizing agent to the dentine surface can have an influence on the bond strengths of the systems.

One study evaluated the efficiency of *Gluma* (glutaraldehyde Heraeus Kulzer, Mitsui Chemical Group, Japan), and *Hyposen* (strontium chloride) (Pharma GmbH + Co, Aachen, Germany) with the bonding systems *Xeno III* (Dentsply, Konstanz, Germany), *AdheSE* (Ivoclar Vivadent, Liechtenstein) and *Clearfil New Bond* (Kuraray, Japan).[15] While *Gluma* had no significant influence on bond strength of the three adhesive systems, *Hyposen* significantly decreased the bond strength values of *Clearfil New Bond*.

Another desensitizing agent, *MS Coat ONE* (SunMedical, Japan), is a water-based, resin-containing oxalate desensitizing agent. The oxalic acid from the agent reacts chemically with calcium ions from the tooth structure to form the insoluble calcium oxalate crystals which block dentinal tubules. Based on this phenomenon, outward fluid flow in the acid-etched dentine can be reduced by applying the oxalate desensitizer prior to adhesive application. As a result, the post-operative dentine hypersensitivity is reduced. However, it has been found that the use of *MS Coat ONE* prior to the application of *Prime & Bond NT* reduces the shear bond strength.

Therefore, the use of a desensitizer agent may be helpful in reducing the incidence of post-operative sensitivity, however, its use may compromise the bond strength of the composite to the cavity wall.[16–19]

Post-operative sensitivity and the type of light source

There are four basic types of dental curing lights:

1. Tungsten halogen;
2. Light-emitting diode (LED);
3. Plasma arc curing (PAC); and
4. Laser.

The two main dental curing lights are the halogen and LED. All curing lights will cure resins, providing that the wavelength delivered by the bulb matches the absorption picture of the photo initiator. The two main categories of light-curing devices use either broader-light-spectrum, quartz-tungsten-halogen bulbs (QTH) with photo-spectrum emissions in the range of 400 nm to 500 nm, or light-emitting diodes (LED) that provide light in the blue-visible spectrum with a range of 450 nm to 490 nm. A light source with low intensity will only cure the top surface of the composite. Incomplete polymerization may be a cause of post-operative pain.

The pulsedelay mode of the LED curing light reduces the incidence and severity of post-operative sensitivity following placement of a posterior composite restoration compared to the fast mode of the same curing light by reducing the amount of cuspal movement.[20] Other studies did not find any significant difference in post-op sensitivity when restoring Class I and II restorations using a soft start polymerization.[21,22]

During composite placement, the light source should be held close to the uncured composite material and an incremental technique used ensuring that the opposing walls are not bonded together. Resin composite should be placed

in successive increments of no more than 2mm and cured. This will result in complete curing, a reduction in polymerization stresses, improved marginal adaptation and decreased cuspal flexure. Both the vertical and oblique incremental techniques have been outlined in the literature.[23,24] The exception to the above technique are the bulk fill resin materials and these will be discussed later in this paper.

Regular assessment of the light-curing device using a radiometer will decrease the risks of post-operative hypersensitivity.

Post-operative sensitivity and the type of composite materials and placement technique

Many factors may be responsible for post-operative sensitivity when placing composite into the cavity:

- Contraction resulting from polymerization shrinkage will cause cusp deflection;[25,26]
- Incomplete coating of the dentine surface with adhesives following acid etching;
- Bulk filling placement using non-bulk fill composite materials;
- Poor adaptation of composite material to internal walls and floors, especially on the cervical floor in an interproximal restoration;
- Occlusal discrepancies. As for all restorations, the occlusion of the new restoration should be checked before discharging the patient. Any discrepancy in lateral or protrusive function may initiate tooth sensitivity.

The incidence of post-operative sensitivity is more frequently reported for Class I and Class V composite restorations due to the configuration factor or C-Factor responsible for the stresses seen in certain designs.[27] This design factor is the ratio between the numbers of bonded walls versus unbonded walls in a prepared cavity. The higher the C-Factor, the higher is the stress resulting from polymerization shrinkage. In Class V and I cavities, the C-Factor is the highest (5/1), since five walls of the cavity are bonded, and only one (the occlusal surface) is unbonded. In a Class IV cavity, the C-Factor is the lowest (1/5), since only one surface of the cavity is bonded and the five others are free. Polymerization shrinkage of between 1.7 and 5.7% of the total volume of the restoration causes the resin to pull away from the cavity wall, leaving a small gap. This gap permits the ingression of oral fluids and bacteria and is termed microleakage with resultant post-operative sensitivity.

Contrary to the widely held opinion of the influence of the C-Factor on the success of composite resin restorations, Ferracane and Hilton outlined, in a recent paper, that there is no direct evidence between contraction stresses in dental composite restorations and reduced clinical longevity.[28] Clinically, it is important that attention be given to the correct placement of posterior composite restorations, especially in Class I and Class V lesions.

The remaining dentine thickness is also correlated to the incidence of post-operative sensitivity. Restorations made in shallow and medium depth cavities showed significantly lower post-operative sensitivity compared with those made in deep cavities.[29] During cavity preparation, only the highly infected, irreversibly demineralized caries should be removed and all remaining dentine is retained and protected.[30]

During the placement of the restoration, the operator should endeavour to achieve, as far as possible, a void-free restoration with close adaptation of the composite to the walls of the cavity.

Post-operative sensitivity with resin restorations is not related to the absence of a protective layer or liner, but rather to the depth of the cavity.[31] The use of glass-ionomer cement liner in occlusal cavities restored with resin composite does not reduce post-operative sensitivity,[32] as the intensity of the pulpal response depends on the remaining dentine thickness.[33]

Flowable composite may result in a better adaptation of the first layer of composite. Flowable resin should be applied in a very thin layer following the application of a bonding agent. The application of a flowable resin to the proximal boxes of Class II composite restorations improve post-operative sensitivity.[34–37]

Two types of matrices are available: metallic and clear or translucent. If a metal matrix is used, then all increments must be cured from the occlusal direction. Similar clinical outcomes were observed after 4 years of placement of Class II restorations using both metallic or translucent matrices.[38]

The layering technique is a concept allowing the dentist to achieve high aesthetic restorations using new systems of resin composites by combining different opacities, but it remains a time consuming procedure. Today, new bulk filling resin systems from different companies are available, relying on different technologies, such as flowable resin composite, sonic energy or fibre-based resin composite.[39] These systems allow optimal composite packing in one or two layers and good adaptation to cavity walls and adequate time for material sculpturing.[40,41]

Bulk filled composites are resins with a modified chemical composition. The practicality of the new material is that it can be light-cured in up to 4–5 mm thickness at once, which will minimize the clinical application time compared to regular composite restorations.[42]

A randomized controlled clinical trial[43] compared the incremental and bulk filling techniques and materials for restoring posterior teeth. At day 7, there was no significant difference between the two groups in terms of post-operative sensitivity or tenderness on biting.

Treatment options for the management of post-operative sensitivity[44,45]

Prevention of post-operative sensitivity is the best line of treatment. A thorough clinical examination of the tooth involved and an investigation of any preclinical symptoms is vital.

Post-operative sensitivity occurring following a composite restoration may continue for a number of days, and it may decrease with time. It is more common in Class I and Class V cavities and, in these cases, it is most likely due to inappropriate filling techniques. If pain persists for longer than 10 days, then the authors would suggest the following protocol:

1. Check the occlusion, especially for non-working interferences;
2. Examine the intensity of the light-curing device;
3. If pain persists, remove the composite and replace with a temporary restoration, glass-ionomer or zinc oxide eugenol cement;[46]
4. If this results in relief of the pain, place a new composite, paying special attention to recommended filling technique;
5. If pain persists, then root canal treatment may be the required treatment.

Conclusion

Achieving a successful composite restoration is technically more difficult than a successful amalgam restoration. Post-

operative sensitivity may become a clinical complication with the placement of a posterior resin system. Furthermore, composite resin placement takes more time than an amalgam placement. The appropriate use of correct materials and techniques will reduce post-operative sensitivity. When preparing the cavity, the appropriate use of burs, and avoiding dehydration of the dentine during the adhesive process, are vital.

Whereas any resultant post-operative sensitivity can be troublesome, the literature would suggest that it tends to decrease over time.[47]

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