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Sensitivity and Composite Restorations

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Abstract

Composite restorations are the most commonly used restorative material used for restoration of teeth. Post-operative sensitivity following the restoration is very common. The causes can vary from depth of cavity, total or partial exposure of dentinal tubules preparation and increased permeability to status of pulp causing increased outward fluid flow rate through the tubules. Sensitivity was elicited by application of cold (ice stick), compressed air, and masticatory forces. Many techniques have been used to overcome this problem. This article discusses about the mechanism of sensitivity following restoration and how to overcome that.

Keywords: Adhesives; Desensitizes; Microleakage; Stress; Sensitivity.

Introduction

Sensitivity is the sign that there is a problem somewhere, It has been common to have postoperative sensitivity (POS) related to adhesive restorations. POS is associated with an increase in dentin permeability and with the residual stresses from shrinkage in adhesive/composite resin restorations that may cause debonding and/or cusp deformation. Polymerization shrinkage forces results in deformation of both restoration and tooth structure, and this transfer hydraulic pressure to the odontoblastic processes to cause pain[1].

Postoperative hypersensitivity can be defined as pain in a tooth associated with mastication or with sensitivity to hot, cold, and sweet stimuli that occurs 1 week or more after restoration. Pain during clenching only usually indicates a restoration in hyperocclusion; however, pain during chewing is considered a form of POH related to polymerization shrinkage gaps between the restoration and dentin that fill with fluid, and during mastication the restoration and tooth deform causing the accumulated fluid to flow down the dentin tubules causing hypersensitivity.[1, 2]

Science behind post-operative sensitivity

Postoperative sensitivity has been attributed to several factors including, residual stress buildup due to polymerization shrinkage resulting in de-bonding of the restoration ensuing in an enamel crack; dentin drying, heat resulting from cavity preparation, microleakage at the margins of the restoration, dentin etching and bacterial penetration of the pulp, occlusal discrepancies, and deformation of the cusps by shrinkage stress and deformation of composite by occlusal forces. Studies have shown that Class I and II restorations placed with a soft start (pulse-delay) technique did not show significant changes in postoperative sensitivity or decreased signs of marginal stress. Polymerization shrinkage, innate to resin composites, can induce stresses at the adhesive interface and can cause cusp deflection due to a damaging cavity configuration which transmits hydraulic pressure to the

odontoblastic processes.[3,4,5] Etching dentine too long may result in etch patterns that extend too deep for the adhesive resins to reach the healthy tooth structure. Depths of about 2 to 2.5 μm are the limit; deeper etching creates voids that may result in a weak link or tooth sensitivity. One aspect that may significantly affect POS is the cavity depth. SE adhesives condition and prime enamel and dentin simultaneously without rinsing; they rely on their ability to partially dissolve hydroxyapatite to yield a resin-infiltrated zone with minerals incorporated. The self-etch adhesives are also classified into three categories based upon their initial pH-value: Mild (pH of 2.5 or more), moderate (pH of approximately 1) and strong (pH < 1), depending on their composition and concentration of polymerizable acids and/or acid resin monomers. Also, studies have proven that the use of a stronger acid resulted in a considerable dissolution and a more defined etching pattern; however, this fact did not translate into higher bond strengths.[6,7,8] Over-etching dentin results in postoperative sensitivity as well as decreases in bond strength due to the demineralization penetrating further into the tubules than the resin tags will go, and formation of a gap. Adhesive systems applied on the dentin allow the dentin fluid to pass through the polymerized resinous materials, but their application significantly reduces dentin permeability.[3,7,9]

Caused by residual stress buildup due to polymerization shrinkage resulting in de-bonding of the restoration ensuing in an enamel crack; microleakage at the margins of the restoration and secondary caries results in postoperative sensitivity. Higher the C – Factor, more are the chances of de-bonding of the composite from the walls of the cavity due to shrinkage. Larger the tooth loss more is the polymerization shrinkage weighing down on the tooth itself and less on the restoration or tooth restorative interface. The soft start method described by Uno and Asmussen uses the premise that a short pulse of light allows the relief of stresses prior to inducing additional stresses during the continuing polymerization. The low irradiance during the photoactivation cycle makes the polymerization reaction to proceed slowly, allowing the relief of shrinkage stresses and decreasing the stress at tooth restorative material interface. Successive cusp buildup technique is placing successive layers of wedge-shaped composite to decrease the C-factor ratio. Wedge shaped composite increments are 1- to 1.5-mm, triangular apico-occlusal layers of uncured composite that are condensed and sculpted directly in the preparation using a composite instrument. The first layer must be very thin and applied to a single dentinal surface without contacting opposing cavity walls.[4, 6, 10, 11]

Pre-operative causes

- Cracks and fractures
- Cervical dentinal exposure
- Pulp condition

Hydrogen ion potential or pH measure of the adhesive systems by action of the conditioner produces metalloproteinase activation, favoring hydrolytic degradation of the collagen fibers. These latent forms are released from the dentine by dissolution of inorganic components as a result of pH reduction during the acid etching processes with the use of both phosphoric acid and application of self-etching adhesives. When the demineralized dentine is not fully infiltrated by the adhesive system, zones of exposed dentine are formed in both conventional etch-and-rinse adhesives and two-step self-etching adhesives. Because of the highly hydrophilic nature of some bonding agents, such as one-step self-etching systems, they can act as permeable membranes, attracting water and degrading faster than more hydrophobic adhesives. One-component self-etch adhesives contain higher concentrations of organic solvent and water than other adhesive systems. Thus, incomplete water removal and evaporation are likely. Self-etching systems are less effective at preparing enamel surfaces and sclerotic dentin.[8, 2,13]

Enamel surfaces require 25 seconds of exposure to phosphoric acid. Dentin on the other hand should not be exposed to the gel for more than 15 seconds. Over-etching dentin results in postoperative sensitivity as well as decreases in bond strength due to the demineralization penetrating further into the tubules than the resin tags will go, and formation of a gap.[12,14]

Selective-etch technique and a self-etch adhesive is used allows a deep acid etch on the enamel margins while maintaining the benefits of a self-etch product, including low postoperative sensitivity and moisture tolerance on dentin.

Type of Adhesives

Anything that can increase the fluid flow movement should increase dentin sensitivity. HEMA-based, etch-and-rinse adhesive, whose preliminary etching step inevitably increases the permeability of dentin owing to the removal of smear layer and smear plugs. In addition to this inherent disadvantage, in case of adhesives containing 13% polyalkenoic acid polymer in an ethanol-water solvent. Polyalkenoic acid copolymers have multi-

ple pendant carboxylic acids along a linear backbone, which tend not only to bind water in the adhesive but also to preclude its penetration into interfibrillar spaces due to its high molecular weight. Moreover, the interfibrillar spaces in the walls of etched tubules are filled with water, which probably dilutes and interferes with resin infiltration. Such incomplete hybridization of resin tags to tubule walls are known to permit fluid movement from dentinal tubules to adhesive interfaces in etch-and-rinse adhesives.[8,9,10]

The absence of postoperative sensitivity comes from not over-etching or over-drying the dentin as part of the protocol. Not having to manage the timing of the material against enamel vs. dentin, or worry about rinsing and drying are advantages all to themselves. Self-etching systems does not have an acid conditioner. Instead, a blend of monomers (UDMA and 4-META) in a high amount of solvents (acetone and water) are present. Glutaraldehyde is another component added to its formula to act as desensitizer.[7,11,12]

Use a total-etch adhesive on your patient's enamel as it can hold up to greater demineralization without causing sensitivity. You just need to make sure to use an adhesive that is viscous enough to stay where you place it and not run onto the dentinal surface. Then, after you have completed the total etch, you apply a self-etch adhesive to both the dentinal and enamel surface (make sure to properly scrub the dentin). [8,9,13]

The seventh-generation adhesive BeautiBond (Shofu, San Marcos, CA) helps to reduce the chances of postoperative sensitivity. It has two functional monomers, BeautiBond facilitates a predictable bond to both enamel and dentin substrates. The phosphonic acid monomer is more stable than phosphoric acid and enhances bonding to enamel, and its carboxylic monomer facilitates a strong, durable bond to the dentin[2, 4].

Bacterial antigens

The presence of bacterial antigens in the pulp causes the release of a host of mediators of inflammation (e.g. histamines, bradykinin, prostaglandins, neuropeptides, etc.). These mediators cause pulpal fibroblasts to begin dividing rapidly in an effort to repair the collagen in the pulpal connective tissue that is being destroyed by polymorphonuclear cell derived matrix metalloproteinases. These fibroblasts express nerve growth factor, which stimulates nearby pulpal nerves to begin sprouting new branches. The nerves multiply, making the region more richly innervated than normal.[15, 16]

Desensitizers and their mechanism of action

Desensitizers are agents that reduce dentin hypersensitivity by reducing movement of intratubular fluid caused by the stimuli and/or by reducing nerve activation by liquor movement. Desensitizers have been advocated for the treatment of dentin hypersensitivity, and it has been suggested that the use of calcium phosphate-based desensitizers is preferable over calcium oxalate-based desensitizers when employed prior to the use of etch-&-rinse adhesives. Oxalate desensitizers are effective in reducing the hydraulic conductance of dentin with exposed tubules because they react with calcium ions on dentin and in dentinal fluid to form sparingly soluble calcium oxalate crystals. These crystals prevent fluid movement without affecting bond between adhesives and dental tissue. Thus, the reduction of dentin permeability is achieved via subsurface tubular occlusion, which should not interfere with the subsequent resin infiltration. The treatment of dentin sensitivity is by restoring the original dentin impermeability.[11,14]

Discussion

Studies show that no significant difference in postoperative sensitivity between a two-step etch-and-rinse adhesive and a two-step self-etch adhesive. The clinical procedure, isolation and the clinician's skills may play a more significant role in postoperative sensitivity than the type of adhesive. Choosing self-etch or etch and rinse adhesives system is not a matter of concern.[5, 6]

Glutaraldehyde coagulates collagen, a major component of dentin. As it coagulates the collagen, microscopic research shows that the thousands of dentinal canals in the tooth are closed, thus reducing the ability of the dentin to transmit pain stimuli to the pulp. They coagulate the dentin, thereby obturating the dentinal canals and reducing the dentin permeability to the subsequently placed resin. When glutaraldehyde is placed on tooth preparations, the teeth are not sensitive postoperatively.[17, 18]

When placing resin based composite, the solution should be placed directly after the tooth preparation is completed before any base, liner, or bonding agent is placed.

Soft-start curing has been found in vitro studies to partially relieve shrinkage stresses and decrease tooth deformation and reduced microleakage. Step curing gave more time for the resin composite to flow, and eventually resulted in reduced stresses on the tooth due to polymerization shrinkage and decreased microleakage.[12, 15, 17]

Conclusion

Post-operative sensitivity is a serious concern for both patient and the treating restorative dentist. Factors that contribute to sensitivity after restoration are many form operator to material. The treating restorative dentist must follow the manufacturer's instructions and proper isolation during the procedure, and the material should be properly cured to avoid post-operative sensitivity. studies have shown that there is no significant difference in sensitivity between total-etch and selective-etch techniques.

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