

Composition of Bonding Agents

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Abstract

Currently many bonding agents are available. Composition of the bonding agent is very important to understand the properties, usage, technique and functions of these agents. Bonding agents are more important than the type of composite we are using for the restoration, as this will affect the longevity of the restoration. This article reviews the composition of currently available bonding agents.

Keywords: Composition, Etching, MDP

Introduction

Composite restoration is the restorative material for direct restorations. For the proper functioning, longevity and survival of the restoration, bonding agent plays a crucial role. Bonding to enamel and dentin is totally different. Proper adaptation of the composite to tooth structure is most important. A good adhesive must also be able to prevent leakage at the margins of the restorations.¹

Composition of dental adhesives

Monomers are the key constituents of adhesives. Two kinds of monomers can be distinguished: cross-linkers (have two polymerizable groups) and functional monomers (commonly have only one polymerizable group). The role of water is to provide the medium for ionization and action of these acidic resin monomers.^{1,2}

HEMA (2-hydroxymethyl methacrylate) exhibit hydrophilic properties. Also, because most of the

acidic monomers are low water-soluble and to increase the wettability of dentin surface, seeks to improve infiltration of the exposed collagen network, which is inherently humid. It also assists in the penetration of liquid filled dentinal tubuli. They bonded to dentin by surface wetting and interaction between their phosphate groups and calcium ions in the smear layer. This has been reported to result in an immediate improvement of bond strength.^{1,3}

Solvents

The role of water is to provide the medium for ionization and action of these acidic resin monomers. Water is a poor solvent for organic compounds (such as monomers). can be overcome by addition of a secondary solvent, such as ethanol and acetone.^{2,4}

10 MDP

The dihydrogenphosphate group from 10-MDP monomer is responsible for etching and chemical

bonding, while its long carbonyl chain provides the hydrophobic properties and hydrolytic stability to this acidic monomer. 10-MDP forms a strong ionic bond with calcium from hydroxyapatite of enamel or dentin, also resulting in Ca salt. MDP has been rated as the most promising monomer for chemical bonding to hydroxyapatite of enamel or dentin. Promotes adhesion to tooth surface by formation of non-soluble Ca²⁺ salts.^{5,6}

MDPB

12-methacryloxy dodecyl pyridium bromide (MDPB) has been reported to act as a matrix metalloprotease (MMP) inhibitor. The pyridinium bromide group of MDPB monomer has antibacterial effects against bacteria by direct contact bacteriolysis.^{3,7}

Matrix Metalloproteinase inhibitors

MMPs are endogenous Zn²⁺- and Ca²⁺-dependent enzymes, capable of degrading almost all extracellular matrix (ECM) components. Mechanisms of MMPs inhibition is cationic-anionic reaction, cationic agents like chlorhexidine (CHX) may electrostatically bind to negatively-charged catalytic sites of MMPs, blocking the active site. Chelating or coordinate covalence bond with zinc or calcium present in the catalytic domain also leads to loss of catalytic activities of MMPs. Chlorhexidine CHX inhibition of proteases may be related to its cation chelating property, and calcium ions released by adhesive primers may be responsible for the loss of inhibition by CHX over time. Adhesives with MMPs has the potential to decrease the degradation of the collagen fibrils within the hybrid layer via inhibiting the host-derived collagenolytic activity.^{4,8}

When primer and bonding resin are applied to etched dentin, they penetrate the intertubular dentin, forming a resin-dentin interdiffusion zone that is the hybrid layer. They even penetrate and polymerize in the open dentinal tubules, and form resin tags. For most of the etch-and-rinse adhesives, the ultramorphologic characterization of the transition between the hybrid layer and the unaffected dentin suggests that a sudden shift from hybrid tissue to unmineralized tissue occurs, without any unfilled space or pathway that can cause leakage. The demarcation line seems to be made of hydroxyapatite crystals embedded in the resin from the hybrid layer. For self-etch systems, the transition is more subtle, with a top layer of resin-impregnated smear residues and a deeper layer, close to the unaffected dentin, rich in hydroxyapatite crystals.^{3,5,9}

Solvents

Solvents are substances capable to dissolve or disperse one or more substances. They govern the viscosity to some extent. They also control the diffusion capability of the bonding agent. Ethanol, acetone and water are the most commonly used solvents. These solvents should completely vaporize and should not remain as it will affect polymerization as it will dilute monomers and may result in porosities and increase the permeability of the adhesive layer. The vapour pressure of the solvent controls the evaporation of the solvent. Multiple times application of primer contributes for a improved adhesion, particularly in dentin. As the solvent evaporates for every adhesive application, the co-monomer concentration increases there by improving the quality of the hybrid layer and the correlation of adhesive layer cured versus no cured due to the oxygen inhibition.^{4,9,10}

Multiple adhesive layers does not contribute to increase the thickness of adhesive layer, but improve the concentration of monomers in the adhesive layer and there by the quality.

Photo-initiators

Most important characteristics of photo-initiators is their peak absorption wavelength and their absorption spectrum. Photo-initiators absorbing in the visible light spectrum are usually used. Also, the maximum absorption wavelength varies based on the solvent, in which the photo-initiator is dissolved. Example Camphorquinone/co-initiator system is the most popular that absorbs over a wide spectrum of wavelengths from 360–510 nm, with peak absorbance around 468 nm (blue light). 1-phenyl-1,2 propanedione (PPD), Acylphosphine oxides are other photo-initiators.^{2,3,11}

Mechanisms of adhesion to enamel and dentin

Etch-and-rinse Adhesives

The main mechanism of bonding resin composites to the phosphoric acid-etched enamel is by the formation of macro tag-like resin extensions inside the space surrounding the enamel prisms and “micro”- tag-like resin extensions formed due to resin infiltration inside the tiny etch-pits at the cores of the etched enamel prisms, acid-etching removes the smear layer and smear plugs.^{5,6,12}

Self-etch bonding agents

Self-etch primers and selfetch adhesive systems are an aqueous solution of acidic functional monomers, with a pH comparatively higher than

that of phosphoric acid etchants. The role of water is to act as a medium for ionization and action of these acidic resin monomers. Self-etch adhesives demineralize and infiltrate into the dentin simultaneously to the same depth, theoretically avoiding incomplete penetration of the adhesive into the demineralized collagen network. The self-etching adhesives systems is indicated for young, deep, permeable dentine as dentinal tubules are more patent compared to aged dentin. The smear layers will be incorporated into the hybrid layer if the solution is not well-agitated (i.e. in distal proximal boxes) or they are completely dissolved if the surface is scrubbed with the bonding agent.

The depth of demineralization of the enamel depends upon the pH of the acid and on the etching time. The pH and the etching time must be enough to provide sufficient enamel retention without the need for additional procedure.^{6,13,14}

Conclusion

Bonding agents with varying concentration of the ingredients that are used are available. Better understanding of the components of the bonding agents will help in improving the results of the restoration survival compounds of bonding agents will help in improving the bond strength, survival of restoration, shelf life. Total etch bonding agents provide better bond strength compare to self-etch.

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