Review Article

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HEMA 4-META in Dental Adhesives

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ABSTRACT

Background: The composition of dental adhesives differs with manufacturers. But regardless of that, 2-hydroxyethyl methacrylate (HEMA) is an essential ingredient in all the adhesives. It helps in bonding to the dentin as its hydrophilic in nature. Its also an essential ingredient in all the dentin desensitizers. Even though it has many advantages, its not without disadvantages. This article highlights the various properties of HEMA and its relevance in adhesion to hard tissues.

Keywords: Disadvantages, functions, HEMA, RMGIC.

INTRODUCTION

HEMA is a versatile low molecular weight hydrophilic monomer that is particularly adept at infiltrating and wetting dentin substrates. It is extremely soluble in water, ethanol, and acetone, and thus easy to incorporate into adhesive formulations. HEMA serves as a wetting agent and helps the monomer to penetrate into the tubules. HEMA is hydrophillic, and actually helps to increase the bond strength of adhesive products and is commonly used. 2-hydroxyethyl methacrylate (HEMA) is a monomer that is based on methacrylic acid (MAA) which is used in the production of biomaterials such as dental adhesive and composite resins 1, 2. It is commonly employed either in three- and two-step etch-and-rinse systems and one reason for this preference is related to its hydrophilicity that makes it an excellent adhesion promoter enhancing bond strength 4, 5, 6. The effect of HEMA is attributed to its polar properties and small dimensions, enhancing the wetting properties of the adhesive and penetration efficacy into the dentin 3, 4 and facilitating subsequent penetration of the bonding resin that copolymerizes with the primer.

Percentage of HEMA in adhesives: The amount of HEMA in adhesives is usually 10% by weight 3.

Functions of HEMA incorporation of HEMA as a hydrophilic co-monomer into the dentin bonding agents improves wetting ability of the adhesives; it provides hydrophilic sites in the structure of the polymerized adhesive. The presence of hydroxyl groups in the chemical structure of the adhesive network increase the water sorption of the adhesive layer which in long term may deteriorate the mechanical properties of the layer and a dramatic drop in the bond strength to the tooth structure. Higher water absorption in hybrid layer, due to the presence of HEMA, could enhance the hydrolytic destruction of the layer 7.

Disadvantages of HEMA

1. HEMA retains water within the adhesive layer and adversely affects the mechanical strength 8
2. 70% of HEMA can be hydrolyzed in acidic solutions within a week at 37°C 9

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3. HEMA provides low photopolymerization reactivity
4. HEMA causes sensitized delayed allergic reactions 10, 11
5. High content of monofunctional monomers in the adhesive impair its polymerization rate.

HEMA for desensitization

HEMA-containing aqueous dentin desensitizers are used for desensitization since HEMA is miscible with water and may form a soft hydrogel after polymerization 12. However, when HEMA-containing primers are used as desensitizers without adhesives, they do not polymerize. Their desensitizing action may be the result of precipitation of plasma proteins within dentinal fluid 13.

HEMA substitutes 18

Cross-linking dimethacrylates are used to overcome the disadvantages of monomers used in adhesives.

1. The rate of polymerization significantly increases because of the gel-effect.
2. The physical properties of a polymer network are improved when compared to linear polymers.
3. The cross-linked layer that forms is not water soluble and the level of swelling decreases with increasing mass of polymer network.

Cross-linking dimethacrylates used in enamel�dentin adhesives are 2,2-bis[4- (2-hydroxy-3-methacryloyloxypropyl)phenyl]propane (Bis-GMA), 1,6-bis-[2-methacryloyloxyethoxycarbonylamino]-2,4,4-trimethylhexane (UDMA), glycerol dimethacrylate (GDMA), and TEGDMA.

4-META

4-META does not require any solvent. Solvents like acetone, alcohol, water, etc. are used in majority dental adhesives. Inadequate evaporation of the solvent can reduce the bond strength and cause post-op sensitivity. As there is no solvent drying the adhesive is not needed; hence time is saved and less margin for mistake. A hybrid layer formed without solvent does not absorb moisture from dentine (water treeing) and the quality and durability of the adhesive connection is increased.

The 4-MET is a monomer which demineralizes and increases adhesion due to the carboxylic groups attached to the aromatic group. The two carboxylic groups are demineralize and increases monomer infiltration, while the aromatic group facilitates the hydrophobic properties, which reduces the acidity and the hydrophilicity from carboxyl groups. 4-MET monomer can form a ionic bond with calcium in hydroxyapatite of tooth, resulting in Ca-4MET salt. To get 4-MET by hydrolytic reaction, water is added to 4-META crystalline powder and when used along with methyl methacrylate (MMA), they form the 4-META/MMA-TBB (tri-n-butyl borane) adhesive 14, 15, 16, 17.

Resin Modified Glass-Ionomers (RMGIC): Hydroxyethyl methacrylate (HEMA) is the resin incorporated in all three materials and the amount added is in the vicinity of 15-20 per cent (by volume) of the liquid. Following mixing at a powder to liquid ratio of 3:1 or greater, there will be less than 5 per cent HEMA in the finished set material 19, 20.

Self adhesive resin cements: For the self-adhesive resin cements, additions to the resin blend consist of highly acidic resin monomers, monomethacrylates, multifunctional methacrylates, and at least one of the new cements includes 4-methacryl-oxyethyl trimellitic acid (4-MET).

additives are included to increase the bond strength to metals (eg, 4-MET) and to resins that bond to ceramic interfaces.

Very low molecular weight monomers as diluents (2-hydroxyethylmethacrylate [HEMA], tetraethyleneglycol dimethacrylate [TEGDMA]) are added to reduce the viscosity of resin cements. The result of using these diluents is that the polymerization shrinkage of the cement increases to about 4% by volume (1.2% linearly), which is of little consequence for cement.

Conclusion: Even though research in the field of adhesives has grown leaps and bounds, 2-hydroxyethyl methacrylate (HEMA) continues to enjoy its position as a vital ingredient in all the adhesives used for bonding to dental hard tissues both in total etch variants and self etch variants. Even though adhesives free of HEMA are available they have less longevity compare to the one having

HEMA. But HEMA free adhesives are definitely a step ahead in the field of dental adhesion.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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