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Short Communication

Novel Dental Adhesive: "A Conception or an Inception"

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A dental adhesive is a material, that join two substrates together and solidifies, and is able to transfer a load from one surface to other [1]. These materials play a pivotal role and are an integral part when it comes to composite restorations.

Because of their esthetics and direct-filling capability, composites and adhesives are widely used restorative materials. Nevertheless, dental composite restorations were reported to be associated with accumulation of biofilms and plaques than amalgams and glass ionomer restorations [2,3]. The acid production resultant by biofilms can decrease the local pH to a cariogenic range of 5 - 4, which could lead to tooth structure demineralization and secondary caries formation which is the reason for failure of composite resin restoration in 50 - 70% cases [4].

A strong and durable adhesion to dental hard tissues is a key factor in the success of the restoration. The mechanism of dentin bonding involves the infiltration of adhesive monomers into a demineralized dentin collagen matrix and the formation of the hybrid layer. The adhesive is not only a connection between the tooth structure and the restorative composite, it also serves as a barrier to protect the demineralized collagen scaffold from the acidic and enzymatic attacks of the oral bacteria, enzymes and fluids. Clinically, residual bacteria could exist in the prepared tooth cavity. In addition, polymerization shrinkage that occurs in traditional resins could allow bacteria to invade the tooth-restoration interfaces. Therefore, it is desirable for the adhesive to be antibacterial to inhibit recurrent caries at the margins. As composite also tends to accumulate plaque, it causes proliferation of bacteria within this marginal gap. Plaque is nothing but deposition of salivary proteins and formation of biofilm so is the need for protein repellent component into the adhesive. Bacteria produces acid causing demineralization of tooth structure and thereby secondary caries to prevent this remineralizing component is requisite [5,6].

Drawbacks of currently available adhesives are microleakage and secondary caries, bacterial adhesion through deposition of salivary proteins and inability to suppress demineralization. To overcome above drawbacks, novel dental adhesive was formulated with triple benefit of calcium-phosphate recharge, protein-repellent and antibacterial functions.

This adhesive consisted of 44.5% of pyromellitic glycerol dimethacrylate (PMGDM) (Esstech, Essington, PA), 39.5% of ethoxylated bisphenol A dimethacrylate (EBPADMA) (Sigma-Aldrich, St, Louis, MO), 10% of HEMA and 5% of bisphenol A glycidyl dimethacrylate (BisGMA) (Esstech). PMGDM and EBPADMA has comparatively less cytotoxicity [7].

PMGDM is an acidic adhesive monomer, and can chelate with calcium ions from the recharging solution to render the resin rechargeable. HEMA was added to improve the flowability and hydrophilicity. BisGMA was added because it could improve the cross-linkage of monomers and the bonding properties of the adhesive. This parent adhesive is referred to as "PEHB" [8,9].

To make the adhesive antibacterial, DMAHDM is added. The protein-repellent agent 2-methacryloyloxyethyl phosphorylcholine (MPC) could be incorporated into resins to repel proteins and bacteria. Nanoparticles of amorphous calcium phosphate (NACP) was added which could release high levels of Ca and P ions to induce remineralization and combat caries. The addition of NACP did not negatively affect the dentin bond strength. Due to their small particle sizes, the NACP readily flowed with bonding agent into dentinal tubules to form resin tags. The NACP adhesive was "smart" because it could substantially increase the Ca and P ion release at a low cariogenic pH when these ions would be most needed to combat caries. For both total-etch and self-etch bonding systems, the bonding stability is limited by the degradation of the HL. The Ca and P ion release from adhesive may be highly beneficial and can serve as seed crystals to facilitate remineralization in HL and at the tooth-restoration margins. Thus, the CaP adhesive may protect the exposed collagen within the bonded interface and improve the bonding stability and durability. Therefore, the NACP-containing adhesive with Ca and P ion release will be helpful in protecting the weak link of the tooth restoration [10].

Additionally, this novel dental adhesive does not affect dentin shear bond strength and has triple benefit of remineralization, anti-bacterial and protein-repellent. It also maintains a safe pH > 6, while commercial traditional adhesive have a cariogenic pH of 4.

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