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Effect of monomer blend and chlorhexidine-adding on physical, mechanical and biological properties of experimental infiltrants

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ABSTRACT

Objectives. The aim of the study was to evaluate antimicrobial inhibition zone, degree of conversion (DC) and Knoop hardness (KH) of experimental infiltrants. Experimental low viscosity monomer blends were prepared and chlorhexidine diacetate salt (CHX) (0.1% or 0.2%) was added comprising the groups: G1) TEGDMA; G2) TEGDMA/0.1CHX; G3) TEGDMA/0.2CHX; G4) TEGDMA/UDMA; G5) TEGDMA/UDMA/0.1CHX; G6) TEGDMA/UDMA/0.2CHX; G7) TEGDMA/BISEMA; G8) TEGDMA/BISEMA/0.1CHX; G9) TEGDMA/BISEMA/0.2CHX. Icon® was used as control group.

Methods. Specimens of resin blends were made ($n = 9$) to accomplished DC and KH. Pour plate was accomplished to evaluate antimicrobial groups' activity against *Streptococcus mutans* (SM) and *Lactobacillus acidophilus* (LA). Data obtained were submitted to two-way ANOVA and Tukey tests for blends comparisons and Dunnett's test for comparisons between experimental infiltrants and Icon® ($p < 0.05$).

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TEGDMA
UDMA
BISEMA

Results. In relation to antimicrobial effect, uncured blends showed higher antibacterial activity than cured ones for the most of blends. After polymerization, G5 showed the highest inhibition zone against SM and, G3 and G6 against LA. Concerning KH, TEGDMA/UDMA-based blends showed the highest values of KH number and it was influenced by monomeric base, regardless CHX concentration. DC was not affected by monomer blend composition, neither for CHX concentration. The antimicrobial activity was affected by monomeric base, CHX concentration and polymerization. Experimental infiltrants presented similar or higher performance than Icon® for the properties evaluated.

Significance. White spot lesion infiltration with low viscosity monomer blends (infiltrants) is an alternative to stop initial caries lesions progression. The incorporation of an antimicrobial agent as chlorhexidine diacetate salt in infiltrants composition could enhance the performance of these materials.

1. Introduction

Minimally invasive dentistry is a concept that involves dental tissue preservation, preferably by preventing disease from occurring and intercepting its progress, but also by removing and replacing dental tissues with as little tissue loss as possible [1]. In the beginning of enamel caries lesions development, the mineral is removed from enamel structure leaving porosities (subsurface lesion), whilst the lesion surface visually remains relatively intact [2,3]. These lesions are clinically recognized as opaque white spots areas on enamel surface.

The pores of enamel caries act as diffusion pathways for acids and dissolved minerals, and an occlusion of these pores by low viscosity monomer blends ("infiltrants") could arrest the lesion progression and mechanically stabilize the fragile lesion structure [4,5]. In order to obtain a deep penetration of the porous layer, the surface must be etched with hydrochloric acid gel and filled with infiltrants as the dimethacrylate triethylene glycol dimethacrylate (TEGDMA) [6–8].

TEGDMA is an extremely fluid monomer and its high flexibility structure chain results in resins with high conversion rate [9]. It forms a polymer network with high cross-link density, although presenting a more heterogeneous structure, with higher water sorption, which causes greater polymer chains entanglement [9]. In this way, TEGDMA-based materials solvent-free have appropriate characteristics for an infiltrant material, once the low viscosity and high degree of conversion also promote good results in mechanical properties as elastic modulus and KH [10]. However, they also show high water sorption and polymerization shrinkage [11,12], as well as high hydrolysis potential in oral environment. Therefore, the addition of hydrophobic monomers as bisphenol A ethoxylate dimethacrylate (BISEMA) or urethane dimethacrylate (UDMA) is interesting, once it could improve the mechanical properties and the long term durability of resin infiltrants in oral environment [10]. The monomers UDMA and BISEMA show a significantly lower viscosity when compared to BisGMA (bisphenol A diglycidyl methacrylate) [13,14].

Adding antibacterial agent in dental resin materials would improve the ability of arresting incipient caries lesions and inhibit plaque accumulation on surface of the material and on surrounding dental tissue [15]. In this way, the addition of an antimicrobial agent such as CHX into resin materials with infiltrant characteristic would include antibacterial properties for these materials, which could reduce biofilm growth over the infiltrated enamel. This would be an important strategy; especially considering that resin infiltrants are indicated for high caries risk patients [8,16,17].

CHX has been incorporated in dental materials, such as glass-ionomer cements, resin-modified glass-ionomer cements and methacrylates, improving and/or extending the antimicrobial properties of these materials against cariogenic bacteria [18–22]. Therefore, adding soluble antimicrobials into resin matrix is a way to release the agent from the materials in a wet environment as oral one, and CHX has been the most frequently used [22–24].

Chlorhexidine has been described as the gold standard for antibacterial application because it is wide spectrum of action [23]. It can suppress the growth of *Streptococcus mutans* and, consequently, prevent dental caries [23,24]. Chlorhexidine is a symmetrical cationic molecule consisting of two 4-chlorophenyl rings and two biguanide groups connected by a central hexamethylene chain, which is considered a strong base and it is stable in the form of salts [25]. At low chlorhexidine concentrations, small molecular weight substances, such as potassium and phosphorus, leach out, exerting a bacteriostatic effect [25]. Nevertheless, in higher concentrations, chlorhexidine shows bactericidal action due to precipitation or coagulation of bacteria's cytoplasm, probably caused by protein cross-linking [25].

Therefore, the incorporation of antimicrobial agents such as CHX in infiltrant composition would allow antimicrobial activity for these materials, especially in relation to cariogenic microorganisms present in incipient carious lesions, which also could decrease bacterial colonization on infiltrated area. Satisfactory results with experimental TEGDMA/UDMA/BISEMA blends with addition of CHX were obtained in a previous study [26] that evaluated properties as: sorption/solubility, flexural strength, elastic modulus and softening. The addition of CHX in two concentrations (0.1% and 0.2%) did not interfere significantly in evaluated testes and experimental blends tested had better performance when they were compared with a commercial control

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