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Bacterial Adhesion and Biofilm Formation on Direct, Tooth-Colored Restorative Materials: An *in vitro* Study

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Abstract

Dental restorative materials are routinely used to restore carious lesions, but over time, they may fail, leading to secondary dental caries. The longevity of restorations appears to depend upon their resistance to bacterial adhesion and biofilm formation.

Objective: To investigate susceptibility of four restorative composite materials to bacterial colonization and biofilm formation.

Methods: 20 circular discs (8x2mm) of four restorative materials, Esthet-X ® HD (Dentslpy), Filtek™ Bulk Fill (3M ESPE), Fuji II® LC (GC America), and Activa™ BioActive-Restorative™ (PulpDent) were prepared and de-contaminated. Streptococcus mutans ATCC 700610, and mixed bacterial oral plaque, were cultured for 24 h, and bacteria were suspended to 1x107 cells/ml. For adhesion assays, quadruplicate composite discs were incubated with one ml *S. mutans* for 24 h. Biofilms of *S. mutans* and mixed bacterial plaque were grown on quadruplicate discs by inoculating them with one ml of bacterial suspension and incubated for 3 weeks. In both assays the bacterial number on each disc was determined by MTT assay.

Results: Fuji and Activa had greater percentages of adherent bacteria (22.8 ± 3.9 and 18.94 ± 4.7, respectively) than Esthet-X (8.12 ± 1.22) and Filtek (5.6 ± 0.94) ($p<0.03$). Both Fuji and Activa also supported significantly greater ($p<0.002$) biofilm growth than Esthet-X and Filtek.

Conclusions: Composite materials appear to differ in their ability to facilitate bacterial adhesion and biofilm formation. The differences in bacterial biofilm formation and retention on the surfaces of the restorative materials demonstrated in this study may be helpful to dentists in selecting restorative composite materials for dental restorations.

Keywords: Dental restorations; Biofilm; Bacterial adhesion; Streptococcus mutans; Plaque bacteria; Secondary caries

Introduction

A permanent, esthetic restorative material that could be placed directly in the mouth to restore cavities in teeth has long been an important contribution in restorative dentistry and oral health. In fact, the uses of direct esthetic restorations have overtaken amalgam, becoming the most common treatment for minimally invasive dental procedures [1]. These esthetic composite materials can be placed as temporary, intermediate, or permanent restorations [2]. However, the term "permanent restoration" can be deceiving, as no dental restoration is truly permanent. Restorations have a limited lifespan which is primarily based on the material used, although other factors contribute to failure such as individual's age, oral hygiene and risk of caries as well as the skill of the dentist placing technique-sensitive materials [2,3].

One of the primary causes of failure of a composite restoration is secondary or recurrent caries. Recurrent caries occurs when a restoration leaks and allows the formation of a cavity beneath the existing restoration. This process requires a susceptible restoration along with bacterial adhesion and accumulation. Different restorative materials have properties such as surface roughness and antibacterial components that modulate this process. However, previous in vitro research has shown that demineralization depth and degradation of the restorative material is bacteria-dependent. Restoration longevity, therefore, is linked to susceptibility towards bacterial colonization [4-6].

Bacterial colonization in the mouth leads to the creation of a biofilm. The formation of superficial biofilm on a dental surface is a complex phenomenon and different key factors are involved [7]. First, formation of salivary pellicle on the biomaterial by adsorption of host saliva proteins [8]. The next step involves the adhesion of the microbial cells, when bacteria begin to anchor. At