

9 Abstract

Although during recent years a caries decline could be detected for most industrialized countries, dental caries remains an important problem. Therefore, continuing development of new preventive strategies and techniques still seems to be indispensable. Due to ethical considerations, the use of in-vivo human and animal studies must be restricted to the minimum. Therefore, it seems to be necessary to develop in-vitro models that allow a simulation of the four etiological factors of dental caries (host, plaque, substrate, and time) in a realistic way and hence an estimate of the caries preventive potential of new measures.

The aim of the present work was to develop a novel biofilm-based caries model for the production of caries-like lesions and to evaluate the model by testing innovative strategies that might be used for the prevention of dental caries in the future.

The biofilm-based in-vitro caries model allowed the continuing cultivation of a *Streptococcus mutans* biofilm for up to nine weeks without unintentional contamination. The model was capable of producing initial primary and secondary caries-like lesions in a reproducible way. The histopathological appearance of the lesions was comparable to naturally induced initial caries lesions. The caries-preventive potential of established measures such as application of fluoride solutions and pit and fissure sealing could be simulated reproducibly, and the model was successfully used to test a set of experimental preventive strategies.

Since self-etching bonding materials allow for etching, priming, and bonding simultaneously, their use as fissure sealants might save application time, minimize steps, and thus minimize the chance for clinical errors. Additionally, their content of hydrophilic monomers might reduce the sensitivity to saliva contamination. However, compared to a conventional sealant (Delton), a self-etching adhesive (Xeno III) used as pit and fissure sealant in the present in-vitro model was equally effective in preventing occlusal caries formation when applied on saliva-contaminated enamel and less effective on non-contaminated enamel.

Based on good laboratory and clinical results with fissure sealing, approaches have been made to extend this preventive concept to smooth enamel surfaces. However, due to the difficult accessibility of proximal surfaces, a standard procedure and

materials have yet to be developed. A pre-cured adhesive monomer patch might be used for this purpose but no data regarding its potential to protect the underlying enamel from bacterially induced acid attacks have been available. Under the conditions of the present in-vitro study, the adhesive patch provided a complete protection against caries. Thus, this study delivered the basis for future clinical studies.

Besides established concepts, biological strategies such as immunization increasingly develop in cariology in order to reduce the pathogenicity of oral biofilms. However, caries prevention by immunization against *S. mutans* does not seem to represent an appropriate strategy because dental caries is not a life-threatening disease. Consequently, concepts focusing on blocking the adhesion of pathogens to the tooth surface might be of importance for future strategies. Recent studies from our laboratory showed that heterogenic-structured glycan solutions have the ability to prevent the lectin-mediated in-vitro adhesion of *S. mutans*. The present study revealed that an experimental glycan solution with anti-adhesive properties was able to reduce the development of caries-like lesions in-vitro and in gnotobiotic rats. These findings provide a new perspective for a biological caries preventive strategy. In terms of a "proof of principle", this strategy might also have high impact on the treatment of microbial infections in other fields of medicine because neither a development of resistance nor of unwanted side effects can be expected.

Because of the reproducibility, the possibility of long operation periods without unintentional contamination, and the possibility to manipulate specimens during operation, the biofilm-based in-vitro caries model seems to be appropriate for studying the outcome of a wide spectrum of new experimental preventive strategies. The model can make an important contribution to reducing necessary animal and human caries studies to the absolute minimum.