Fluorine activity of antibacterial ammonium hexafluorosilicate solution for the prevention of dental caries

Toshiyuki Suge and Takashi Matsuo
Department of Conservative Dentistry, Institute of Health Biosciences, The University of Tokushima Graduate School, 3-18-15 Kuramoto, Tokushima 770-8504, JAPAN

Ammonium hexafluorosilicate [SiF: (NH₃)₂SiF₆] was prepared in order to overcome the tooth discoloration caused by diamine silver fluoride [AgF: (NH₃)₂AgF] application. However, the antibacterial activity of SiF seems to be weaker than that of AgF due to silver having a high antibacterial activity. To increase the antibacterial activity of SiF for the prevention of dental caries, various antibacterial agents were added to SiF solution. The aim of this study was to evaluate the fluoride activity of the several antibacterial SiF solutions.

Four kinds of antibacterial SiF solutions were prepared with the addition to chlorhexidine (CHX), cetylpyridinium chloride (CPC), isopropyl methylphenol (IPMP), or epigallocatechin gallate (EGCG), respectively. Hydroxyapatite powder and pellets were treated with SiF solution with or without antibacterial agents for 3 min. And then, the pellets were immersed in demineralized solution for 24 hours. Demineralized depth of hydroxyapatite pellets after several SiF treatments were measured by surface roughness analyzer. Also, crystallinity of hydroxyapatite powder before and after several SiF treatment was measured with powder X-ray diffraction (XRD) analysis.

XRD analysis was shown that formation of calcium fluoride on hydroxyapatite surface was decreased with the addition of antibacterial agents to SiF solution. SiF+CPC solution showed equivalent acid resistance (demineralized depth) compared to SiF and AgF treatment. In contrast, the original acid resistance activity of SiF solution was diminished by the addition of other antibacterial agents (CHX, IPMP and EGCG). SiF with the addition of CPC was the most effective for reducing the demineralized depth, showing the same level as SiF and AgF, in contrast, the addition of other antibacterial agents to SiF reduced the original acid resistance activity of SiF solution.

It was concluded that the the addition of CPC to SiF solution was not reduced the fluorine activity of SiF solution, indicating that it may be useful for the prevention of dental caries.

Keywords: ammonium hexafluorosilicate; dental caries

References

From mono-functional enzymatic coatings to bi-functional coatings to impair Staphylococci adhesion

D. Alves and M. O. Pereira
1Centre of Biological Engineering, LIBRO – Laboratório de Investigação em Biofilmes Rosário Oliveira, University of Minho, Campus de Gualtar, 4710-057 Braga, Portugal

Despite the remarkable advances in modern healthcare, there are some drawbacks associated to the extended use caused by diamine silver fluoride [(NH₃)₂AgF] application. However, the antibacterial activity of SiF seems to be weaker than that of AgF due to silver having a high antibacterial activity. To increase the growing number of BAI has led to the need of developing novel antibacterial coatings for medical devices. The use of enzymes able to degrade biofilm matrix components, such as proteins and extracellular DNA, represents a promising approach to fight these infections.

The first aim of this study was to apply a biologically inspired strategy for covalent immobilization of different enzymes (lysozyme, proteinase K and DNAs I) on clinically relevant substrata (silicone) to obtain mono-functional coatings able to prevent staphylococci adhesion or to kill the adhered bacteria, depending on the enzyme used. The coating developed with the best anti-adhesive properties was afterwards combined with an antimicrobial peptide (colistin), generating a bi-functional coating.

Compounds immobilization was mediated by a polydopamine (pDA) coating and the anti-adhesive and antimicrobial performances of the generated surfaces were investigated for a clinical isolate of Staphylococcus aureus using fluorescence microscopy.

Results showed that unmodified silicone allowed the adhesion of bacteria without compromising their viability. Silicone modified with polydopamine coating had no significant effect on bacterial attachment and viability. Lysozyme immobilization was not able to reduce bacterial attachment or compromise their viability. On the other hand, proteinase K was able to reduce the percentage of bacterial attachment and a significant fraction of these adhered bacteria was found dead. Regarding the functionalization with DNase I, these coatings presented the best anti-adhesive properties and since it is know that this enzyme is not cytotoxic, it was further combined with colistin and the bi-functional coating obtained proved to be more effective on reducing the fraction of bacterial attachment.

The overall results suggest that the use of coatings functionalized with enzymes is able to degrade biofilm matrix components and their conjugation with antimicrobial peptides presents a promising strategy for creating antibacterial surfaces to be applied in biomaterials for medical devices and implants.

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