In vitro and in vivo correlations of silicate –based bioactive glasses

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Abstract

Over the years, the understanding of the interactions of bioactive glass with biological processes has steadily increased. From the glass technology point of view, the capability of the bioactive glasses to stimulate and support tissue regeneration depends on their poor chemical durability. Fundamentally, the release of inorganic ions from the bioactive glass is decisive for its tissue regenerative capability. Traditionally, the ability of a particular glass composition to form a hydroxyapatite surface layer in a solution mimicking the human extracellular fluids is used to prove its bioactivity. The hydroxyapatite layer provides a chemical bonding between the glass and the biological apatite in bone tissue. Today we know that the ions dissolving from the glass have an essential function: when released at controlled concentrations, they stimulate the cellular processes and thus enhance the tissue regeneration. Accordingly, increasing research efforts are paid to tailor glasses, which release inorganic ions known to enhance not only bone but also soft tissue regeneration. In vivo studies are used to demonstrate for example the bonding of the bioactive glass to tissue, the thickness of the reaction layers formed at the glass surface, or the quality of the new tissue after various implantation times. In contrast, the observations from long-term clinical follow-up studies of implanted bioactive glasses are rare. In this presentation, the in vitro ion dissolution kinetics and the hydroxyapatite layer formation are correlated with the in vivo layer formation at several bioactive glasses. The goal is to enhance the understanding of the in vitro dissolution kinetics on the in vivo bioactivity of the glass. Finally, the in vitro, in vivo and clinical results of one composition, the bioactive glass S53P4, are discussed.

Keywords: bioactive glass, dissolution kinetics, in vitro, in vivo

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