Chapter 8

Boron-Containing Bioactive Glasses for Bone Regeneration

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8.1 INTRODUCTION

Bioactive glasses have been widely investigated as biomaterials for specific applications in medicine, dentistry, pharmacology, cosmetics, and biotechnology. Bioactive glass materials are surface active and form a stable bond with round, hard, and soft tissues. Hench and coworkers first made bioactive silicate glass 45S5, referred to as Bioglass, with the chemical composition: 45% SiO_2, 24.5% CaO, 24.5% Na O, and 6% P_2O_5 (by weight) (Hench et al., 1971). The bioactivity of a glass is usually evaluated by its ability to form a hydroxycarbonate apatite or a hydroxyapatite (HAP) on its surface upon immersion in a simulated body fluid (SBF). HAP is chemically very similar to the mineral component of bone (Dorozhkin, 2016). Its presence on the glass surface promotes further attachment of biomolecules, cells, and tissue growth factors, which then favor the development of bonds with surrounding tissues and the creation of new bone tissue and wound healing. One major disadvantage of silicate bioactive glasses is their incomplete conversion to HAP material after in vivo implantation, which may limit their biomedical application. The incorporation of boron in silicate bioactive glasses leads to lower chemical durability. Owing to their low chemical durability, some borate glasses can convert more completely and rapidly to HAP in SBF than their silica counterparts. Boron-containing glasses have been shown to support cell proliferation and differentiation in vitro (Richard, 2000; Zhou et al., 2016), as well as the enhancement of new bone formation and wound healing in vivo (Richard, 2000; Marion et al., 2005). The first silica-free borate glass composition (45B5), analogue to 45S5 Bioglass, was investigated by Richard (Richard, 2000). In vitro experiments indicated that an HAP layer forms on the surface of the 45B5 glass upon immersion in a phosphate solution. The borate glass provided a marginally suitable environment for the growth of MC3T3-E1 bone cells due to the release of boron. In vivo experiments demonstrated bone growth around the 45B5 glass particles, very similar

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