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Synthesis and in vitro Characterization of a Gel-Derived SiO2-CaO-P2O5-SrO-Li2O Bioactive Glass

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Abstract : Bioactive glasses (BGs) are a group of surface-reactive biomaterials used in clinical applications as implants or filler materials in the human body to repair and replace diseased or damaged bone. Sol-gel technique was employed to prepare a SiO₂-CaO-P₂O₅ glass with nominal composition of 58S BG with the addition of Sr and Li modifiers which imparts special properties to the BG. The effect of simultaneous addition of Sr and Li on bioactivity and biocompatibility, proliferation, alkaline phosphatase (ALP) activity of osteoblast cell line MC3T3-E1 and antibacterial property against methicillin-resistant Staphylococcus aureus (MRSA) bacteria were examined. BGs were characterized by X-ray diffraction, Fourier transform infrared spectroscopy, scanning electron microscopy before and after soaking the samples in the simulated body fluid (SBF) for different time intervals to characterize the formation of hydroxyapatite (HA) formed on the surface of BGs. Structural characterization indicated that the simultaneous presence of 5% Sr and 5% Li in 58S-BG composition not only did not retard HA formation because of opposite effect of Sr and Li of the dissolution of BG in the SBF but also, stimulated the differentiation and proliferation of MC3T3-E1s. Moreover, the presence of Sr and Li on dissolution of the ions resulted in an increase in the mean number of DAPI-labeled nuclei which was in good agreement with live/dead assay. The result of antibacterial tests revealed that Sr and Li-substituted 58S BG exhibited a potential antibacterial effect against MRSA bacteria. Because of optimal proliferation and ALP activity of MC3T3-E1cells, proper bioactivity and high antibacterial potential against MRSA, BG-5/5 is suggested as a multifunctional candidate for bone tissue engineering.

Keywords : antibacterial activity, bioactive glass, sol-gel, strontium
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