Risedronate-Loaded Macroporous Gel Foam Enriched with Nanohydroxyapatite: Preparation, Characterization, and Osteogenic Activity Evaluation Using Saos-2 Cells

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Abstract

The application of minimally invasive surgical techniques in the field of orthopedic surgery has created a growing need for new injectable synthetic materials that can be used for bone grafting. In this work, novel injectable thermosensitive foam was developed by mixing nHAP powder with a thermosensitive polymer with foaming power (Pluronic F-127) and loaded with a water-soluble bisphosphonate drug (risedronate) to promote osteogenesis. The foam was able to retain the porous structure after injection and set through temperature change of PF-127 solution to form gel inside the body. The effect of different formulation parameters on the gelation time, porosity, foamability, injectability, and in vitro degradation in addition to drug release from the prepared foams were analyzed using a full factorial design. The addition of a co-polymer like methylcellulose or sodium alginate into the foam was also studied. Results showed that the prepared optimized thermosensitive foam was able to gel within 1 min at 37ÁC, and sustain the release of drug for 72 h. The optimized formulation was further tested for any interactions using DSC and IR, and revealed no interactions between the drug and the used excipients in the prepared foam. Furthermore, the ability of the pre-set foam to support osteoblastic-like Saos-2-cell proliferation and differentiation was assessed, and revealed superior function on promoting cellular proliferation as confirmed by fluorescence microscope compared to the plain drug solution. The activity of the foam treated cells was also assessed by measuring the alkaline phosphatase activity and calcium deposition, and confirmed that the cellular activity was greatly enhanced in foam treated cells compared to those treated with the plain drug solution only. The obtained results show that the prepared risedronate-loaded thermosensitive foam would represent a step forward in the design of new materials for minimally invasive bone regeneration.

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