Therapeutic biomaterials for chronic wound healing

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Abstract

Chronic wounds are a significant clinical challenge, as the body's natural healing process is often unable to overcome the inflammatory phase. The development of biofilms and compromised blood flow, which hinders oxygen delivery to affected tissues, are major factors contributing to chronicity. To address this issue, this doctoral thesis proposes a novel approach by designing therapeutic biomaterials with multiple functions to enhance wound healing. The research focuses on developing three types of dressings with distinct main activities: (1) oxygen-releasing dressings using alginate-based hydrogels with polymeric microspheres of polylactic acid containing hydrogen peroxide and supplementary addition of Matrigel ; (2) antimicrobial dressings incorporating silver nanoparticles synthesized using a microfluidic platform, allowing for controlled physico-chemical properties; and (3) dual-activity dressings combining oxygen-releasing tanylated calcium peroxide nanoparticles and antimicrobial silver nanoparticles. The developed materials were characterized using various techniques, including XRD, FTIR, SEM, TEM, DLS, FT-ICR MS, and UV-Vis Spectroscopy. Additionally, biological assessments were conducted using histopathology (Dane and Hematoxylin-Eosin staining), fluorescence microscopy, MTT, LDH, and NO tests. The efficacy of the materials in inhibiting biofilm development was evaluated against three bacterial strains: *Staphylococcus aureus*, *Pseudomonas aeruginosa*, and *Escherichia coli*. The results demonstrate the potential of these therapeutic biomaterials as a valid solution for promoting the healing of chronic wounds. The novel approaches presented in this thesis offer a promising avenue for advancing the treatment of chronic wounds and improving patient outcomes.