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Mesoporous Titania Thin Films for Gentamicin Delivery and Bone Morphogenetic Protein-2 Immobilization

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Abstract : The antibacterial capacity of bone-anchoring implants can be improved by the use of antibiotics that can be delivered to the media after the surgery. Mesoporous films have shown great potential in drug delivery for orthopedic applications, since pore size and thickness can be tuned to produce different surface area and free volume inside the material. This work shows the synthesis of mesoporous titania films (MTF) by sol-gel chemistry and evaporation-induced self-assembly (EISA) on top of glass substrates. Pores with a diameter of 12nm were observed by Transmission Electron Microscopy (TEM). A film thickness of 100 nm was measured by Scanning Electron Microscopy (SEM). Gentamicin was used to study the antibiotic delivery from the film by means of High-performance liquid chromatography (HPLC). The Staphilococcus aureus strand was used to evaluate the effectiveness of the penicillin loaded films toward inhibiting bacterial colonization. MC3T3-E1 pre-osteoblast cell proliferation experiments proved that MTFs have a good biocompatibility and are a suitable surface for MC3T3-E1 cell proliferation. Moreover, images taken by Confocal Fluorescence Microscopy using labeled vinculin, showed good adhesion of the MC3T3-E1 cells to the MTFs, as well as complex actin filaments arrangement. In order to improve cell proliferation Bone Morphogenetic Protein-2 (BMP-2) was adsorbed on top of the mesoporous film. The deposition of the protein was proved by measurements in the contact angle, showing an increment in the hydrophobicity while the protein concentration is higher. By measuring the dehydrogenase activity in MC3T3-E1 cells cultured in dually functionalized mesoporous titatina films with gentamicin and BMP-2 is possible to find an improvement in cell proliferation. For this purpose, the absorption of a yellow-color formazan dye, product of a water-soluble salt (WST-8) reduction by the dehydrogenases, is measured. In summary, this study proves that by means of the surface modification of MTFs with proteins and loading of gentamicin is possible to achieve an antibacterial effect and a cell growth improvement.

Keywords : antibacterial, biocompatibility, bone morphogenetic protein-2, cell proliferation, gentamicin, implants, mesoporous titania films, osteoblasts
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