Handbook on Nanobiomaterials for Therapeutics and Diagnostic Applications

Polyelectrolyte multifaceted magnetic microcapsules for magnetic drug targeting at rheumatoid arthritic joints

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Abstract:
Background: Drug delivery is a science that requires the development of tailored systems that can deliver defi nedquantities of a therapeutic payload at a specifi c target site, at a controlled release rate, with or without a specifi c trigger.However, several drug molecules cannot be formulated or administered by standard techniques as they exhibit poorwater solubility or have limited stability in the human body. Polymeric multilayer capsules assembled using layer-by-layertechnique (LbL) are promising candidates for complex tasks, such as storage, encapsulation, and release. These carrierscan be readily engineered and functionalized with desired properties and are also fl exible for specifi c changes withrespect to mechanical stability, elasticity, morphology, biocompatibility, permeability, and surface characteristics.Multifunctionality and its ability to respond to various stimuli that can aff ect and control their properties are the mostsignifi cant advantages of polyelectrolyte multilayered (PEM) capsules. Aim: The present study was aimed to develop a Fe-drug-loaded microbullets using a novel hybrid technology formagnetic targeted therapy and its comparative evaluation on rheumatoid arthritis. Methodology: Methotrexate magnetic microcapsules (MMC) and prednisolone magnetic microcapsules (PMC) weredeveloped using the techniques detailed later. Poly(sodium 4-styrenesulfonate) (PSS)-doped porous CaCO coremicroparticles were prepared by biomimetic mineralization method and its surface morphology was observed andanalyzed using SEM, followed by which particle size distribution, zeta potential, functional group characterization, thermal stability, porosity, and crystallinity were evaluated. Drug-loaded PSS-doped CaCO core microparticles weredeveloped using solvent evaporation technique, and the resulting complex was assessed for drug loading and entrapmenteffi ciency. Anionic poly(sodium 4-styrenesulfonate) and cationic poly(allylamine hydrochloride) in a suitableconcentration were added alternatively up to 5 cycles to the drug incorporated PSS-doped CaCO microparticles by layer-by-layer procedure. Previously, iron oxide nanoparticles as ferrofl uid prepared by coprecipitation technique were addedin between the polyelectrolyte layers during the cycle. The CaCO core was preferentially removed to yielded drug-loadedmagnetic microcapsules. The formulated MMC and PMC were evaluated for its morphology by SEM and TEM, particlesize distribution, and zeta potential with zeta sizer, functional group characterization with FT-IR spectrometer, staticmagnetic properties with vibrating sample magnetometer, dynamic magnetic susceptibility with AC susceptometer, andstability studies. Adjuvant-induced arthritis rat model was used to evaluate the therapeutic effi cacy of optimized MMCand PMC. Paw volume, hematological, biochemical parameters, radiological, and histopathological studies showed bettertherapeutic activity than standard drug.