Dextran-verteporfin Coated SPION Micelles for Magnetic Resonance Imaging and Photodynamic Therapy

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Photodynamic therapy (PDT) has developed in recent years as a non-invasive and highly selective approach for cancer treatment. However, most clinically approved photosensitizers are poorly water-soluble drugs and cannot be administered intravenously directly. Therefore, a widely pursued aim is the optimization of the delivery strategy of these hydrophobic photosensitizers to improve PDT efficacy. Herein, we developed a novel, superparamagnetic iron oxide (SPIO) loaded, dextran-b-dendritic poly(amidoamine) (PAMAM) platform to deliver PDT drug verteporfin (BPD) for the treatment of breast cancer cells (4T1) in vitro. Dextran-b-dendritic poly(amideamine) (PAMAM) was prepared via the click reaction between dextran-alkynyl and N₃-PAMAM. The prodrug Dextran-b-PAMAM/BPD conjugates were prepared by conjugation of BPD to the periphery amine groups of PAMAM, according to the EDC/NHS method. We then dissolved Dextran-b-PAMAM/BPD conjugates in an organic solvent to encapsulate hydrophobic SPIOs to form Dextran-verteporfin coated SPION micelles in water. We outline multiple methods for studying and confirming the structure of as-prepared nanoparticles. The nanoparticles had an average hydrodynamic diameter of ~54 nm with a polydispersity index (PDI) of 0.134 based on dynamic light scattering measurements. In addition, they exhibited superparamagnetic properties with an r2 value of 542 mM⁻¹ s⁻¹ which demonstrated its potential as a contrast agent for Magnetic Resonance Imaging. Upon investigation using timed cellular uptake, the nanoparticles showed an increase in fluorescence intensity over prolonged time periods, indicating cellular uptake. Moreover, MTT studies revealed that the Dextran-verteporfin coated SPION micelles were minimally toxic without light and would significantly reduce cell viability once exposed to light at a wavelength of 690 nm. In summary, we have developed a novel liner-dendritic Dextran-verteporfin coated SPIO nanoparticle platform for photodynamic therapy. We believe that this platform can be further employed to deliver other photosensitizers, anticancer agents, and to perform as a contrast agent for MRI.