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Biodegradable Polymeric Vesicles Containing Magnetic Nanoparticles, Quantum Dots and Anticancer Drugs for Drug Delivery and Imaging

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Abstract : With appropriate encapsulation in functional nanoparticles drugs are more stable in physiological environment and the kinetics of the drug can be more carefully controlled and monitored. Furthermore, targeted drug delivery can be developed to improve chemotherapy in cancer treatment, not only by enhancing intracellular uptake by target cells but also by reducing the adverse effects in non-target organs. Inorganic imaging agents, delivered together with anti-cancer drugs, enhance the local imaging contrast and provide precise diagnosis as well as evaluation of therapy efficacy. We have developed biodegradable polymeric vesicles as a nanocarrier system for multimodal bio-imaging and anticancer drug delivery. The poly (lactic-co-glycolic acid) PLGA) vesicles were fabricated by encapsulating inorganic imaging agents of superparamagnetic iron oxide nanoparticles (SPION), manganese-doped zinc sulfide (MN:ZnS) quantum dots (QDs) and the anticancer drug busulfan into PLGA nanoparticles via an emulsion-evaporation method. T2-weighted magnetic resonance imaging (MRI) of PLGA-SPION-Mn:ZnS phantoms exhibited enhanced negative contrast with r2 relaxivity of approximately 523 s-1 mM-1 Fe. Murine macrophage (J774A) cellular uptake of PLGA vesicles started fluorescence imaging at 2 h and reached maximum intensity at 24 h incubation. The drug delivery ability PLGA vesicles was demonstrated in vitro by release of busulfan. PLGA vesicles degradation was studied in vitro, showing that approximately 32% was degraded into lactic and glycolic acid over a period of 5 weeks. The biodistribution of PLGA vesicles was investigated in vivo by MRI in a rat model. Change of contrast in the liver could be visualized by MRI after 7 min and maximal signal loss detected after 4 h post-injection of PLGA vesicles. Histological studies showed that the presence of PLGA vesicles in organs was shifted from the lungs to the liver and spleen over time.

Keywords : biodegradable polymers, multifunctional nanoparticles, quantum dots, anticancer drugs
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