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Targeted and image-guided cancer treatment using Theranostic nanoparticles

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Recent advances in nanotechnology have opened an exciting frontier in developing and applying novel approaches for the detection and treatment of human cancer. The major challenges in clinical oncology are the selective delivery of large amounts of therapeutic agents into tumor cells, accurate evaluation of the drug delivery, timely assessment of the therapeutic response and effective treatment of drug resistant cancers. Nanomaterial is playing a pivotal role in cancer diagnostics and therapeutics due to their unique optical, electronic, and magnetic properties. Theranostic nanoparticles with the abilities to target tumors, carry therapeutic agents, and produce contrasts for tumor imaging offer a promising means for novel treatments of cancer patients. We have developed a multifunctional theranostic magnetic iron oxide nanoparticle (IONP) platform that utilizes receptor-targeted IONPs to carry single or multiple therapeutic agents for drug delivery and optical and magnetic resonance imaging (MRI). Our theranostic nanoparticles are designed to overcome physical and intrinsic barriers that reduce efficiency of drug delivery and confer drug resistance in human cancers. By targeting to cellular receptors that are highly expressed in tumor cells, angiogenic endothelial cells, and active tumor stromal cells, these IONPs allow the drug to overcome the physical barrier in stroma-rich tumors, such as pancreatic cancer and triple negative breast cancer (TNBC), by serving as carrier vehicles for passage through the tumor endothelial cell layer and stromal fibroblasts, thereby increasing the efficiency of delivery into tumors but not into normal tissues. Based on the surface functionalization of the IONPs and chemical properties of drug molecules, we developed approaches for encapsulating or conjugating drugs to the IONPs, resulting in theranostic IONPs which carry one or multiple therapeutic agents. Targeted delivery, drug release, tumor growth inhibition, and MRI of drug delivery and response have been demonstrated in orthotopic breast and pancreatic cancer animal models. Conjugation of a new near infrared dye with a lasting-signal to the theranostic nanoparticles provides an optical imaging modality that allows identifying and removal drug resistant residual tumors by image-guided surgery. Therefore, our theranostic IONPs have the potential to significantly improve the efficiency of cancer treatment, Current preclinical studies focus on the development of an integrated protocol for the treatment of locally advanced pancreatic and triple negative breast cancers using targeted neoadjuvant nanotherapy and image-guided surgery.

Biography

Dr. Yang is an Associate Professor of Surgery and Radiology and Nancy Panoz Chair of Surgery in Cancer Research at Emory University. Dr. Yang received her medical training in China at West China University of Medical Sciences and then in the Chinese Academy of Preventive Medicine. She received her PhD degree in Molecular and Cellular Biology at Brown University. She was a research fellow in gene therapy at the University of Southern California and Emory University before joining the Department of Surgery at Emory as an Assistant Professor. Dr. Yang's research has concerned liver stem cells and cancer, gene therapy, apoptosis, molecular targeted therapy, biomarker targeted drug delivery, and cancer nanotechnology. During the last several years, she leads a research team to develop targeted optical and magnetic resonance imaging (MRI) nanoparticle probes for early detection of breast and pancreatic cancers and for image-guided therapy and surgery. Her group has developed a theranostic magnetic iron oxide nanoparticle (IONP) platform that utilizes receptor-targeted IONPs to carry single or multiple therapeutic agents for drug delivery and multi-modality tumor imaging. Her current research also focuses on molecular targets and signal pathways that confer aggressive behavior, invasiveness and resistance to apoptosis in triple negative breast cancer. Dr. Yang is the PI of several research projects supported by NIH R01, NIH P50 Emory Molecular Imaging Center, and NIH U01 Cancer Nanotechnology Platform Partnership grants. Her research has resulted in several patent applications. Dr. Yang is a member of the editorial boards of Apoptosis and Breast Cancer-Targets and Therapy. She is a member of the NIH Developmental Therapeutics study section and has served in many other NIH study sections.