Future Applications of Paramagnetic Nanoparticles

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Nanomedicine combines the myriad advances in a broad range of disciplines with developments in nanotechnology to offer new opportunities for assessment and treatment of patients. In particular, the development of ligand-directed paramagnetic nanoparticles provide a synergy of molecular imaging and targeted drug delivery, which may have important applications in both cancer and cardiovascular disease. In recent years a variety of paramagnetic nanoparticle based agents have emerged. Most are soft, lipid-based systems, but examples of solid polymeric, dendrimers, and metal-oxide based agents have been explored.

One illustrative example is a multi-modal site-targeted contrast agent based on perfluorocarbon emulsions, which has been demonstrated to provide sensitive and specific imaging of molecular epitopes and local therapy in multiple animal models of cancer and cardiovascular disease. This novel platform has been used to detect angiogenesis, fibrin, tissue factor and collagen III and to locally deliver therapeutic agents through a unique mechanism we term “contact-facilitated drug delivery”.

In cardiovascular disease, these agents can be used to recognize intraluminal microthrombus on ruptured, atherosclerotic plaque, quantify neovascular expansion associated with progressive atherosclerosis and deliver antiangiogenic therapy, or intramurally deliver anti-restenotic therapy following angioplasty alone or associated with non-drug eluting stents.

In cancer, the agents can improve the recognition and characterization of early solid tumors, well beyond the capability of digital mammography. As with cardiovascular disease, paramagnetic perfluorocarbon nanoparticles may be used to confirm and quantify targeted therapeutic delivery as well as serially monitor response. Over the next decade, paramagnetic molecular imaging in conjunction with rational targeted therapies, will likely impact all of us. No single technology offers a solution for all problems. However, the emerging cadre of “image-based nanotools” offers a rich palette of diagnostic and therapeutic approaches to address long-standing clinical problems from a new perspective.