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Multifunctional Nanomedicine Platforms for Imaging and Treatment of Cancer and Other Diseases

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Extended Abstract

The Taratula laboratory focuses on the development of nanomaterial-based platforms for imaging and targeted eradication of endometriosis and cancer. Thermal therapy (hyperthermia), a clinical intervention to ablate cancerous tissue by increasing the temperature of the tumors, is one of our major research directions. Different strategies can be used to elevate intratumoral temperatures for cancer treatment. For example, nanoparticle-mediated magnetic hyperthermia is a form of thermal therapy where nanoparticles delivered to disease sites generate heat after exposure to an external alternating magnetic field. Many studies have validated the significant potential of magnetic hyperthermia to either kill cancer cells directly or enhance their susceptibility to radiation and chemotherapy. Despite its promising potential, magnetic hyperthermia is currently limited to the treatment of localized and accessible tumors because the required therapeutic temperatures (>42 ^{0}C) can only be achieved by direct intratumoral injection of conventional magnetic nanoparticles. To overcome this, we have developed novel nanoparticles that efficiently accumulate at tumor sites following intravenous injection and generate desirable intratumoral temperatures (>42 ^{0}C). A significant portion of our research is also focused on nanomedicine-based image-guided photothermal therapy. We develop nanoparticles that efficiently delineate cancer lesions with fluorescence signals following systemic injection and eliminate them with heat upon exposure to targeted near-infrared light. Our research team also demonstrated that some fundamental principles of cancer nanomedicine can be used for the development of novel nanoparticle-based strategies for the treatment of endometriosis. Endometriosis is a devastating disease characterized by the presence of endometrium-like tissues outside of the uterus, and there is no cure for this disorder. To tackle this issue, we validated that the aforementioned nanomedicine strategies are also effective for the diagnosis and eradication of endometriotic lesions.