Hybridized Manganese Dioxide & Gold-Iron Oxide Nanoparticle Inhibition of Tumor Growth via Radiosensitization and Tumor Microenvironment Control

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While controlled bombardment of cancer cells via ionizing radiation remains the leading form of cancer treatment, its effectiveness is often limited by damage caused to neighboring healthy tissue. Recent innovation in cancer treatment focuses on the use of paramagnetic Au-Fe3O4 nanoparticles that, once positioned, display strong surface plasmon resonance, which leads to thermal ablation, a natural and oxygen-free method of heat generation that quickly kills targeted and localized cancer cells. Separately, A-MnO2 nanoparticles have been shown to regulate cancer tumor microenvironments through simultaneously limiting hypoxia and acidosis to enhance radiation response by preventing tumor aggressiveness. This research investigates novel synthesis of biocompatible hybrid A-MnO2-Au-Fe3O4 nanoparticles, so that both therapies can be realized concurrently, once the magnetically-responsive hybrid NP's are accurately positioned. 15nm A-MnO2 nanoparticles were synthesized via a modified Prassad method, while 2-14nm Au-Fe3O4 NP's were synthesized via a modified Yu method, all of which were supported by SEM/EDS. Hybrid A-MnO2-Au-Fe3O4 were then formed by the combination of A-MnO2:Au-Fe3O4 (1:3M) via 60oC sonication in 0.2% PVA. SEM/EDS analyses confirm the creation of PVA coated hybrid nanoclusters (PVA-HNC; ~20nm), that remain magnetically responsive. In a simulated tumor environment, these PVA-HNC's would limit hypoxia, or slow tumor aggressiveness, as 45μM quenched 94% of 1.1mM H2O2 in 40min. Additionally, surface plasmon resonance of the PVA-HNC's was achieved. Irradiation of 100μM PVA-HNC demonstrated increased radiation signature versus a PVA-Fe3O4 colloidal suspension of equal scattering concentration. Overall, PVA-HNCs performed markedly better than the individual parts.