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Self-Controlled Hyperthermia & MRI Contrast Enhancement via Iron Oxide Embedded Hydroxyapatite Superparamagnetic particles for Theranostic Application

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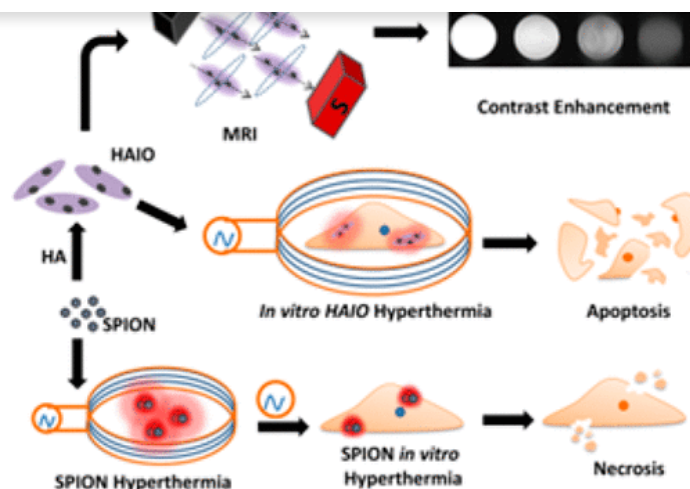
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Increasing effectiveness of cancer therapeutics requires a multipronged approach. Delivery of controlled hyperthermia in the ranges of 43 to 45 °C on site aided by superparamagnetic particles ensures cell death via the apoptosis pathway. We demonstrated the use of iron-oxide embedded hydroxyapatite (HAIO) superparamagnetic particles for delivery of controlled hyperthermia and contrast enhancement in MRI. To determine optimal hyperthermia delivery, we used 5 and 10 mg/mL concentrations of HAIO on various magnetic fields in alternating magnetic field (AMF) study. Time–temperature profile and specific loss power (SLP) data revealed that HAIO delivered precisely controlled temperature in contrast to superparamagnetic iron oxide nanoparticles (SPIONs). Earlier studies had demonstrated that HAIO concentrations of 0.5 to 3 mg/mL are cytocompatible. Exposure of HeLa cells to HAIO at a concentration of 2 mg/mL and applied field of 33.8 mT for a period of 30 min resulted in apoptosis induction in 75% of population. Significant cellular disruption was affirmed via FACS, ESEM and cLSM techniques. An aqueous phantom study and *in vitro* cell culture study evaluation indicated relaxivity of 50.92 mM⁻¹ s⁻¹ and good pixel intensity variation in MRI. The current study assesses the potential of HAIO to deliver controlled hyperthermia and act as a negative MRI contrast agent. Repeated experiments have confirmed enhanced utility of the technique in the burgeoning field of theranostics.

KEYWORDS: diagnosis, therapy, alternating magnetic field, magnetic hyperthermia, apoptosis, necrosis

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Supporting Information

The Supporting Information is available free of charge on the [ACS Publications website](#) at DOI: [10.1021/acsbiomaterials.8b00244](https://doi.org/10.1021/acsbiomaterials.8b00244).

- Detailed descriptions of HAIO and SPION synthesis; hydrodynamic size analysis via DLS; particle size distribution via TEM; crystallite size of iron oxide by XRD analysis; magnetic resonance imaging contrast efficiency testing of HAIO; cLSM techniques and images ([PDF](#))

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