Functionalized magnetic nanoparticles as candidates for Alzheimer's disease

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Central nervous system (CNS) disorders remain one of the most dominant challenges faced by modern medicine with Alzheimer's disease (AD) being the most prevalent and incurable cause of dementia owning to very few available drugs and ineffective drug delivery strategies. The idea of having a "doctor" inside a body is a good metaphor for nanomedicine while the ability to carry out diagnosis and therapy simultaneously (termed as theranostics) is gaining popularity thanks to unique features of advanced nanosystems. Magnetic nanoparticles (MNPs) are protagonists in various bioapplications, one of them being effective T2 imaging agents in magnetic resonance imaging (MRI) with many in clinical trials as well as commercial products (e.g. Ferridex). MNPs functionalized with AD drugs in the form of nanocarriers can emerge as the next generation AD theranostics *via* 'smart' surface chemistry architecture to overcome issues of inadequate Blood Brain Barrier (BBB) crossing and poor pharmacokinetics of AD drugs. We have undertaken a study to prepare small (<10nm) Zinc Ferrite MNPs with various zinc doping (ZnxFe3-xO4, 0.3<x<0.8), high magnetization (>120 emu/g) and T2 imaging ability (r2>200 mM-1s-1). A microwave assisted polyol process was employed for the synthesis of the inorganic nanocrystals while Oleic Acid (OA) and Oleylamine (OAm) where utilized to tailor the organic surface. In that manner, hydrophilic Zinc Ferrite MNPs@OA with free surface carboxylate groups (-COOH) were fabricated and Memantine, an established AD drug, was conjugated on their surface. Additionally, hydrophobic Zinc Ferrite MNPs@OAm were encapsulated along with a fluorescent-modified Memantine in the core of sodium dodecyl sulfate (SDS) nanoemulsions. Structural and physicochemical characterization was carried out for primary MNPs. Drug loading efficiency, release mechanism, hydrodynamic size, surface charge and MRI imaging ability were estimated for the fabricated nanocarriers. The ultimate goal is to present an inorganic organic hybrid multimodal nano-formulation as a new AD theranostic.