Nanodiamond based magnetic nano-vectors for multimodal imaging and magnetic drug targeting

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Abstract:

Cancer remains the second most common cause of death all around the world, accounting for nearly 1 out of every 4 deaths. Many different types of nanoparticles (NPs) have been synthesized in recent years with the goal of using them as tumor drug delivery vehicles. Among those nanoparticles, nanodiamond is known for its physicochemical properties, biocompatibility, and fluorescence properties that don't photo-bleach. In this work we have used magnetic nanodiamond (MND) functionalized with HSA to carry anthracycline drug Doxorubicin (DOX) which can be vectored and targeted using an external magnetic field. The magnetic nanodiamond exhibited excellent stability and biocompatibility. The MND localization in the A549 cells were confirmed using confocal microscope. Furthermore, the MND exhibited a shorter fluorescence lifetime decay than the A549 cells, making it easier to detect inside the cells. By utilizing the magnetic property of the diamond, using an external magnetic field the enhanced cellular uptake and the distribution of the particle incubated with the cells have been demonstrated using flow cytometry and Two-Photon fluorescence microscopy. Upon loading MND with DOX and exposing it to a magnetic field when incubated with A549 exhibited significant toxicity. An IC50 calculation of nanodiamond DOX complexes exposed to MF indicates that they require a lower concentration than free DOX. Based on these results, MND could be used as a potential carrier to deliver drugs to affected areas using an external magnetic field, which would increase the bioavailability of the drugs inside the cell and allow tracking of the cells using fluorescence imaging.

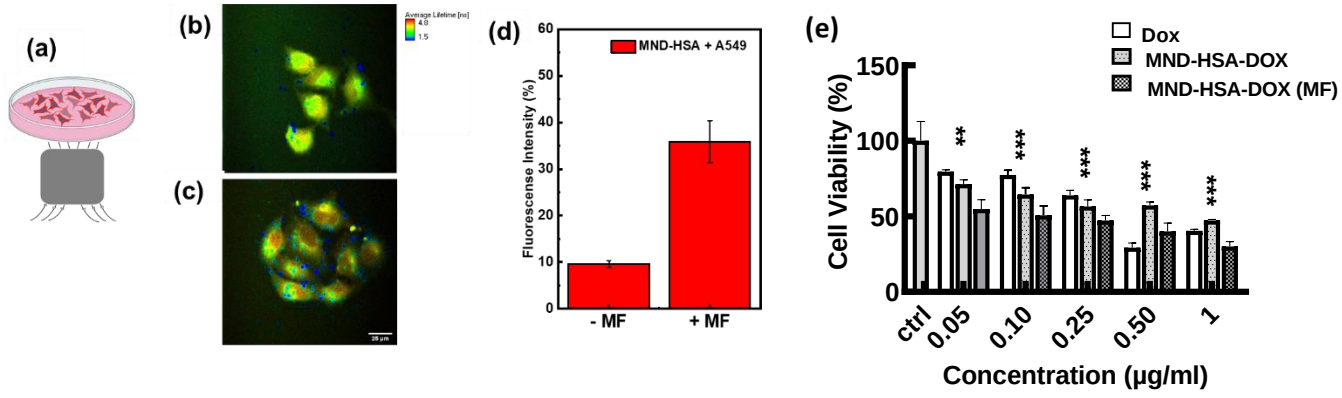

Fig. 1 (a) schematic representation of particle incubated with cells exposed to a static magnetic field. Imaging of cellular uptake of 20 µg MND-HSA in a homogenously dispersed medium using 2-photon imaging. (c) without and (c) with magnetic field. (d) Flow cytometry measurements of MND-HSA uptake in A549 cells with (+ MF) and without (-MF) magnetic fields. (e) the cell viability measured at 48 hours incubated with various concentrations of DOX, MND-HSA-DOX, MND-HSA-DOX (MF) exposure to the magnetic field. The particle exposed to the magnetic field demonstrated enhanced therapeutic efficacy in comparison to that of the particle not exposed. N=3.