In vitro safety and efficiency of iron oxide nanoparticles to treat cancer with magnetic hyperthermia

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Abstract: According to the latest reports from the World Health Organization, cancer is one of the leading causes of death worldwide having killed nearly 8.2 million people in 2012 (1). Therefore, finding new ways to cure cancer or prolong life expectancy, while avoiding important side effects, is a great challenge for scientists. In this sense, magnetic hyperthermia (MHT) has emerged as an experimental anti-cancer treatment that may be used either alone or as a sensitizing strategy. The aim of this study is to evaluate the *in vitro* ability of magnetic nanoparticles to efficiently kill cancer cells using magnetic hyperthermia.

U87MG cells (ATCC® HTB-14™), an *in vitro* model of human glioblastoma, were used to perform the study using poly-acrylic acid coated SPIONs with an average core diameter around 18nm. Different SPION concentrations were initially tested to evaluate overall cytotoxicity using the PrestoBlue reduction assay. After choosing the SPION concentration to be used (0.5 g/L), different combinations of amplitude and frequency of field were tested in order to obtain heating curves reaching deadly temperatures (between 41-46ºC). When applying 869kHz+225*Oe* until the sample reached 46ºC, no significant difference was observed in cell viability. Nevertheless, decreasing the intensity of the applied external magnetic field (499kHz+275*Oe* or 688kHz+250*Oe* until 44 or 46ºC were reached), therefore prolonging the exposure time to deadly temperatures, leads to a significant decrease in cell viability (of more than 50%). This fact was confirmed microscopically by double staining the cells with Annexin-V and Propidium Iodide, which are cell death indicators of apoptosis and necrosis pathways, respectively.

The results suggest that MHT application to cells exposed to SPIONs at tolerable magnetite concentrations induces significant cancer cell death especially when prolonging the time of exposure to temperatures above 41ºC for at least 30 minutes.

Keywords: cell viability; superparamagnetic iron-oxide nanoparticles; magnetic hyperthermia; cancer treatment

References: (1) World Cancer Report 2014, Edited by Bernard W. Stewart and Christopher P. Wild

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