Nanoparticle Enhanced Electromagnetic Control of Cancer Cell Development for Nanotheranostics

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Nanomaterials are being considered in the development of new drugs and new therapies and have been used in tissue engineering and medical imaging, leading to improved diagnostics and new therapeutic treatments. Nanotheranostics is referred to as a treatment strategy that integrates nanotechnology and therapeutics to diagnostics, aiming to monitor the response to treatment, which would be a key part of personalized medicine and require considerable advances in predictive medicine. A major limitation in the current treatments such as chemotherapy, radio therapy for cancer is the negative side effects that occur. Recently non-invasive therapy including electrical therapy and magnetic therapy recently has made significant progress based on the deep understanding of biophysical and bioelectrical properties of biomolecules and the development of nanotechnology and fabrication technology.

Recently we demonstrated a whole cell-based array-formatted electrical impedance sensing system to monitor the effects of external alternating electric fields on the behavior of ovarian cancer cells HTB-77™ (SKOV3) compared to normal human umbilical vascular endothelial cells CRL-1730™ (HUVEC). The biosensor employed will measure in real-time the electrode surface impedance changes[2] produced by growing cell monolayers over the electrodes and detecting any changes in resistance associated with changes in the cell layer after electric field exposure[3]. A significant effect on slowing down proliferation rate was observed in the cancer cells through the lower resistance curves of the electrical impedance sensing system in real-time as the external field was applied compared to a control with no applied field. Upon further investigation of this technique, our group has found that the therapeutic effects of the electric therapy technique can be significantly increased by functionalizing the surface of cancer cell membranes with gold nanoparticles, this is specifically true for breast cancer tissue[2]. The binding of charged nanoparticles to the cell surface plasma membrane will change the zeta potential value of the cells, a feature of the cell that has been used in cell biology to study cell adhesion, activation, and agglutination based on cell-surface-charge properties. We determined that an enhanced electric field strength can be induced via the application of nanoparticles, consequently leading to the killing of the cancerous cells limited effects on non-cancerous cells. This discovery will be helpful for developing an electronic therapeutic platform for non-invasive cancer treatment without limited harmful side effects.

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