Conductive nanoparticles used as nanoamplifiers in electroporation

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Electroporation consists in the application of short-duration high-intensity electric field pulses to modify the permeability of the cell membrane. This technique has been demonstrated to be highly effective in the introduction of different types of molecules in the cell cytoplasm. Specially electrochemotherapy, which consists in the introduction of chemotherapeutic agents, has been successfully used in vivo in the treatment of cutaneous and subcutaneous tumors in humans. To advance the applicability of electroporation, innovative approaches to increase its efficiency and homogeneity are necessary.

In this study we assess the possible use of conductive nanoparticles in combination with electroporation to improve the effect of the electric field on cells. We propose that the local modification of the electric field in the presence of a conductor material could be used as a strategy to locally amplify the intensity of the external electric field applied at the cell membrane level. In this way, the conductive nanoparticles acting as nanoamplifiers [1] would increase the level of electric field around them. This would consequently lead to a drastic reduction of the external electric field intensity required to achieve effective cell electropermeabilization.

The first results in vitro of this study indicate that the presence of nanoparticles at the cell membrane enhance both the proportion of permeabilized cells and the level of permeabilization itself. The results are confirmed using different types of nanoparticles all of them having high conductivity.

This innovative study highlights the potential of conductive nanoparticles for enhancing the efficiency of electroporation via the amplification of local electric field. Moreover, this approach paves the way for a promising in vivo application.

1. Qiu et al., Simulation of nanoparticles based enhancement of cellular electroporation for biomedical applications, J. Appl. Phys, vol 116, 184701, 2014.