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Nanosecond Electric Pulses for Anti-Cancer Treatment

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Electric pulses can effectively treat advanced, inoperable, chemo- and radiation-resistance cancers. This technique, known as electroporation, involves the application of high intensity, short duration (nanosecond (ns)) pulses. Depending upon the energy applied, which is a function of the magnitude, length, and number of pulses, one can potentially induce no membrane change, temporary opening of the cell membrane after which cell survives (reversible electroporation), or permanently open the cell membrane and induce cell death (irreversible electroporation (IRE)). When a suitable electric field is applied to the cancer cells, IRE permanently permeabilizes the cell membranes, resulting in a loss of cell homeostasis [1, 2]. The advantages of IRE are that it has a drug-free, non-thermal mechanism of action that allows focal tissue ablation and requires a very short time of application. IRE also allows ablation of tumors in close proximity to other tissues with no protein denaturation.
This study evaluates the efficacy of IRE for various ns pulse parameters on human, triple negative breast cancer cells, MDA-MB-231. Specifically, we applied different numbers (8, 20, and 40) of 35kV/cm, 60ns pulses to assess the impact of delivering different energy levels and assessed the viabilities were 24 and 72h after treatment. The viabilities varied from 71% to 33% following 8 pulses (untreated control at 100%), 28% to 8% after 20 pulses and 21% to 7% after 40 pulses. These results indicate the sustainable effect of a single application of electrical pulses, even after 72h. This suggests that it is possible to tune cell death and proliferation control to achieve complete tumor ablation by appropriately tuning the electrical parameters.

[1] B. Rubinsky, G. Onik, and P. Mikus, "Irreversible electroporation: a new ablation modality –Clinical implications", Technology in Cancer Research and Treatment, Vol. 6, No. 1, pp. 37-48, Feb 2007.
[2] B. Rubinsky, "Irreversible electroporation in medicine,"Technology in Cancer Research and Treatment, Vol. 6, No. 4, pp. 255-259, August 2007.

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