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## Study on inducing apoptosis and stimulating the irreversible electroporation effect for tumor treatment based on high frequency nanosecond pulsed electric field

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To solve the problems involved in tumor treatment using pulsed electric fields (PEF), we presented a novel tumor treatment method using high-frequency nanosecond pulsed electric fields (nsPEF) modulated by microsecond pulse based on both apoptosis and irreversible electroporation, also aiming at direct killing effects of microsecond pulsed electric fields ( $\mu$ sPEF) and indirect modulating effects of nsPEF. In order to verify the validity of the method which we presented, the human melanoma cells A375 were used to carry out some vitro experiments. And the self-developed unipolar high frequency nanosecond pulse generator was used to produce the pulse. To find the optimal values of the pulse parameters, ensure that still has a good effect in the case of low field strength, a series vitro cell experiments were carried. The pulse string number was fixed to 100, and changed pulse width (100ns, 250ns, 500ns), electric field amplitude (1, 2, 3, 4 kV/cm), and burst frequency (1, 10, 100, 1000kHz), respectively. The tumor cells survival rate after 0h and 24h which handled by pulsed electric field was detected by MTT and CCK-8, and the tumor cells apoptosis rate after 4h and 24h was detected by Annexin V-PI double-staining method. The experimental results show that this method can effectively kill tumor cells and induce its apoptosis, it is obviously that the feasibility of this method is verified. And the condition of electric field intensity and frequency is more suitable for the human body, which can solve many problems in future practical application.

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