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Dose effect of high frequency nanosecond pulse bursts on muscle contraction of rabbit in vivo

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In the process of treating tumor with nanosecond pulsed electric fields, the muscle contraction is inevitable. The purpose of this paper was to study the effect of different parameters of high frequency nanosecond pulse bursts on the rabbit muscle contraction strength. Ten unipolar high frequency pulse bursts with different field intensities (3 kV/cm, 5 kV/cm and 10 kV/cm), intra-burst frequencies (10 kHz, 100 kHz and 1 MHz) and intra-burst pulse numbers (1, 10 and 100) were applied through a pair of plate electrode to the surface skin of the rabbit's biceps femoris, and the acceleration signal of muscle contraction near the electrode was measured with a three axis acceleration sensor. The time and frequency domain characteristics of the acceleration signal were analyzed. The time domain analysis of the acceleration signal shows that with the increase of the strength of the pulse sequence, the amplitude of the acceleration signal of the muscle contraction will also increase and the vibration of the acceleration signal is more intense when the parameters are stronger. The frequency domain analysis of the acceleration signal shows that the frequency spectrums of the acceleration signal measured under different pulse bursts are similar. This suggests that the frequency of muscle contraction is determined by the inherent resonance frequency of the muscle tissue. Further analysis of the experimental results illustrate when the intra-burst frequency is relatively low, appropriate increase in the intra-burst pulse numbers will not increase muscle contraction strength significantly; however when the intra-burst frequency is relatively high, the intra-burst pulse numbers should be minimized as far as possible. This will provide reference for the selection of parameters in the actual tumor treatment performed with high frequency nanosecond pulses in the future.

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