

Analysis of Heart Defibrillation by an Exponential Pulse

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Abstract – Threshold dependence of the "strength-duration", for exponential pulses is calculated and compared with the results of animal heart defibrillation.

Keywords –heart defibrillation, exponential pulse, characteristic of "strength-duration".

I. INTRODUCTION

The main purpose of defibrillation is to interrupt ventricular arrhythmia with the lowest electrical discharge to avoid myocardial damage, which is often observed while using high-energy. Therefore, the choice of the form and the value of energy of defibrillating effects is an important task.

II. THE BASIC MATERIAL

Frequency selective excitation of a neuron model [1] is used to analyze the action of exponential pulse on the heart defibrillation

$$U(t) = U_H e^{-\frac{t}{T}},$$

where: U_H – initial voltage across the capacitor discharge C , $T = RC$ – time constant, R – resistance of the animals chest.

Frequency-transfer function model is

$$K(j\omega) = \frac{K_0 j\omega a}{(j\omega + 2a)(j\omega + a)}$$

where α – filter parameter, which determines the resonance frequency.

The output energy E through the energy spectrum $S_{in}(\omega)$ of the input exponential effect, will be

$$E = \frac{1}{P} \int_0^{\infty} S_{in}(\omega) |K(j\omega)|^2 d\omega.$$

If the value of E is known we can find the characteristics of the "strength-duration", which determines a regular dependence between the value of the threshold voltage U with the exponential effect duration T on fibrillatory heart that to stop his fibrillation

$$U = U_R (1 - 2,67e^{-\frac{aT}{2}} + 2e^{-aT} - 0,33e^{-2aT})^{-\frac{1}{2}},$$

where U_R – the voltage rheobase.

Fig.1 shows the per unit threshold voltage (rheobase value) depending on the relative duration αT of exponential impact. The experimental threshold values of defibrillating voltage under the influence of an exponential pulse effects on dogs and cats terminating fibrillation are showed by the dots on the figure 1 [2]. exponential impact. In this case we have almost complete correspondence between the theoretical and experimental results.

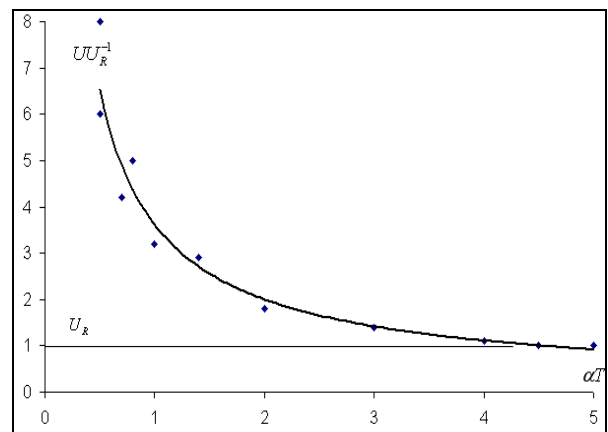


Fig.1. The threshold curve "strength-duration" at the heart defibrillation

III. CONCLUSION

Dependence of the "strength-duration" of the animal heart defibrillation by exponential pulse of different duration on the basis of frequency selective excitation model is theoretically calculated. Complete correspondence between the theoretical and experimental results of heart defibrillation for cats and dogs is observed.

REFERENCES

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