Gorbunov B., Gusev A., Gusev D., Filatov I., Itkin G., Konysheva E., Mamekin K., Mikitas A., Nesterenko I., Rygalin D., Selishchev S., Trukhmanov S and Vostrikov V.

Automated Complex for Experimental Researches of Efficiency External Defibrillators/Cardioverters at Various Waveforms and Parameters of Electrical Pulses

Introduction

In spite of intense research into this problem, there is still no agreed-upon theory of mechanisms of electric defibrillation that would be able to explain most experimental data [4].

The efficacy of electrical defibrillation therapy at terminating ventricular fibrillation is highly dependent on the waveform used, waveform parameters, waveform impedance-compensation schemes, and relative shock magnitudes. This has lead to an extensive, experimental search for the optimal waveform, the optimal waveform being the waveform which achieves the highest defibrillation efficacy with the least amount of energy from the defibrillator [1-3,5].

At low-impedance, all biphasic shocks achieved near-perfect success, while efficacy was significantly lower for high-impedance shocks [5]. Despite impedance-compensation schemes in biphasic defibrillators, impedance has an impact on their efficacy. At high-impedance, modest efficacy differences exist among clinically available biphasic defibrillators, reflecting differences in both waveforms and manufacturer-provided doses.

During action of an electrical pulse transthoracic impedance changes, and there is a nonlinear dependence between an electrical current and voltage [1].

Russian automated complex for experimental researches of efficiency external defibrillators /cardioverters at various waveforms and parameters of electrical pulses, real-time measuring of transthoraric electrical impedance during external defibrillation is presented. There are module for heart fibrillation of animals (dogs and pigs), module for defibrillation/cardiversion procedures and module for monitoring of physiological parameters of the animals.

Material and Methods

This study was approved by the Russian Research Institute of Transplantology and Artificial Organs at Animal Laboratory (Fig.1).

Fig. 1: General view of automated complex

The module for monitoring of physiological parameters of the animals contains display (monitor), invasive pressure sensors, ECG sensors, multichannel universal analog-to- digital converters (ADC), personal computer (PC) and uninterrupted power source (UPS) (Fig.2).

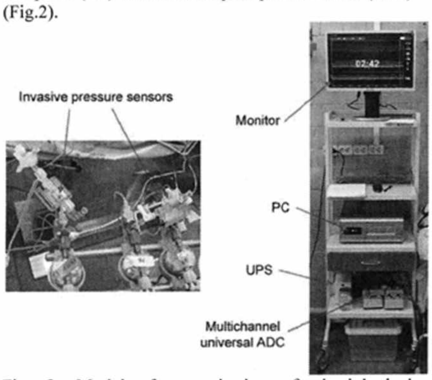

Fig. 2: Module for monitoring of physiological parame-ters of the animals.

Bloc-diagram of module for defibrillation/ cardiover-sion procedures is presented on Fig.3.

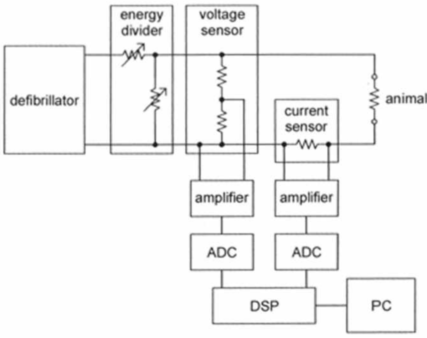

Fig. 3: Bloc-diagram of module for defibrillation/ cardioversion procedures.

Energy divider provides a rough choice of energy value for defibrillation/cardioversion. Voltage and current sensors detects the real electrical parameters on animal. Then these signals amplify, transformed to digital form (ADC) and processed by digital signal processor (DSP). Personal computer (PC) provides additional calculations and in real time displays the information.

General view of module for defibrillation/cardiover-sion procedures is presented on Fig.4.

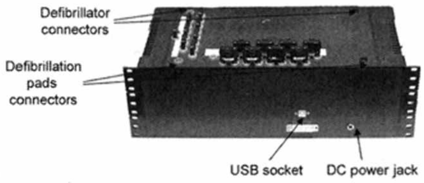

Fig. 4: General view of module for defibrillation/cardio-version procedures.

Results

Typical curve for dependence of animal impedance on electrical current through animal is presented on Fig.5.

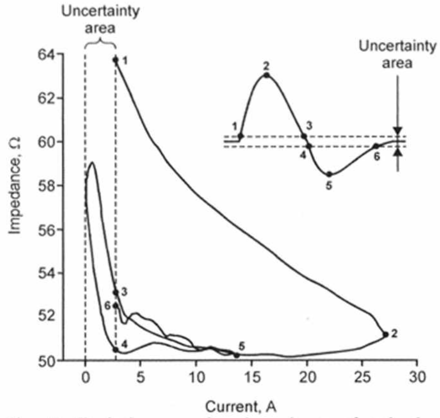

Fig. 5: Typical curve for dependence of animal impedance on electrical current through animal. In the right top of figure the defibrillation waveform is shown. Pulse duration – 10 ms.

At an initial stage of pulse the impedance decreases (from point 1 to point 2). Further the impedance continues to decrease, and then begins increases (from point 2 to point 3). Impedance again decreases in a point 4. In the end of pulse the impedance again decreases (from point 5 to point 6).

Thus, there is a nonlinear dependence between animal impedance and electrical current through animal. On this dependence there are sites of monotonous and nonmonotonic (from point 4 to point 6) change of impedance. The impedance is close for points 3 and 6, but differs for points 3,6 and 4.

The animal impedance is virtually a pure resistance.

Discussion

The designed complex allows to realise experimental researches of efficiency external defibrillators /cardio-verters at various waveforms and parameters of electrical pulses, real-time measuring of transthoraric electrical impedance during external defibrillation/cardioversion on animal models.

There are module for heart fibrillation of animals (dogs and pigs), module for defibrillation/cardiversion procedures and module for monitoring of physiological parameters of the animals.

There is a nontrivial, nonlinear dependence between animal impedance and electrical current through animal.

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