ROLE OF CARDIAC MASS IN SPONTANEOUS DEFIBRILLATION

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In the earliest studies of the nature of fibrillation the view was expressed that the existence of fibrillation is determined by the ratio of the duration of the refractory period and the velocity of conduction of excitation, i.e., it depends on the length of the trajectory of circulation of excitation [2]. This view was subsequently analyzed in model experiments, and the concept of critical mass appeared, namely the smallest mass of tissue in which fibrillation can still take place [5]. However, in experiments on heart tissue cultures, it was shown that the fibrillation process can take place in the smallest volume imaginable, namely only a few cells [3].

The aim of the present investigation was to determine the role of cardiac mass in spontaneous defibrillation.

EXPERIMENTAL METHOD

Experiments were carried out on 25 guinea pigs, six rabbits, 19 chickens, and 28 pigeons, anesthetized with hexobarbital (100 mg/kg body weight, intraperitoneally) and maintained on artificial ventilation of the lungs. Ventricular fibrillation was induced by application of a series of square pulses with a frequency of 50 Hz, duration 2 msec, duration of volley 1 sec, and amplitude 2-4 thresholds to the heart.

Transmembrane potentials of cardiomyocytes of the left ventricle of the intact heart in the course of fibrillation were recorded by means of floating microelectrodes, their parameters were determined relative to the standard criteria, and the duration of the period of spontaneously reversible ventricular fibrillation (SRVF) also was obtained.

EXPERIMENTAL RESULTS

The results of the experiments on guinea pigs are shown in Fig. 1a, b. It will be clear that consecutive application of electrical stimulation to the same heart leads to the onset of periods of SRVF of varied duration. Comparison of the cardiac mass and duration of the period of SRVF after the first stimulation (Fig. 1b) shows that with the same cardiac mass the duration of the period of SRVF may differ by as much as 3-5 times.

It can be seen in Fig. 1c that in rabbits the relationship between duration of the period of SRVF and the cardiac mass does not differ significantly from the results obtained on guinea pigs, even though the cardiac mass is 4-6 times greater in rabbits than in guinea pigs.

In cocks SRVF appeared in 25% of cases after the first electrical stimulation, compared with 35.7% in hens (Fig. 2a, b). The cardiac mass in chickens, moreover, is smaller than in guinea pigs and rabbits.

In experiments on pigeons, electrical stimulation of the heart led in all cases without exception to the appearance of spontaneously irreversible ventricular fibrillation (Fig. 2c).

It must be emphasized that the parameters of transmembrane potentials did not differ from one another either in the control or during the course of SRVF.

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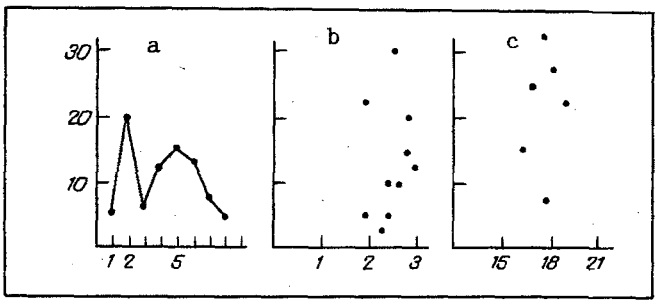

Fig. 1. Dependence of duration of period of SRVF on serial No. of stimulation (a) and cardiac mass (b — guinea pig, c — rabbit). Abscissa: a) serial No. of stimulation, b, c) cardiac mass (in g); ordinate, period of SRVF (in sec).

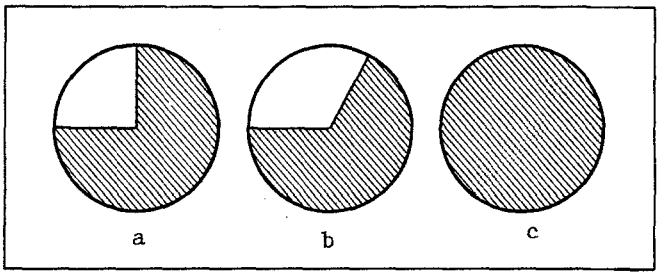

Fig. 2. Ratio (in %) of spontaneously reversible (unshaded part of circle) and spontaneously irreversible (shaded part of circle) ventricular fibrillation in cocks (a), hens (b), and pigeons (c).

The results thus give no grounds for the assertion that cardiac mass determines the ability of the heart to undergo spontaneous defibrillation. In our view, a much more important factor is the ultrastructural organization of the heart tissue and, in particular, the small number of tight junctions in the avian heart [4], so that synchronization of excitation is impaired and ventricular fibrillation is not spontaneously reversible. An important role is played by parasympathetic control of cardiac activity. In fact, as was shown previously [1], intensification of parasympathetic control prevents spontaneous synchronization of excitation and the cessation of fibrillation in guinea pigs. It will be clear from the results presented above that in animals with marked parasympathetic tone (cocks, pigeons) SRVF expressed as percentage is significantly less than in animals with a low level of tone of the vagus nerve centers.

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