AUTOMATIC CONTRACTIONS OF THE SPECIFIC VENTRICULAR MUSCLE OF THE ISOLATED RABBIT HEART

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The effect of adrenalin, acetylcholine, the chlorides of potassium, calcium, and magnesium, strophanthin, novocainamide, and caffein on contractions of the specific ventricular muscle, maintaining or deprived of its connections with the myocardium of the ventricle, was studied in an isolated preparation of the rabbit heart in which the left ventricle was divided after removal of the sinus node and the auricles. The electrical activity and mechanical contractions of the left branch of the bundle of His and the mechanical activity of the myocardium of the left ventricle were recorded simultaneously. The investigation showed that specific muscle of the ventricles, after removal of the sinus node and interruption of its functional connection with the myocardium, maintains not only its automatic contractions but also its ability to react to pharmacological substances injected into the coronary vessels.

Experiments have shown that specific musculature of the ventricles differs from ordinary myocardium not only structurally [2, 13], electrophysiologically [12, 15], and biochemically [10, 11, 14, 16], but also in its resistance to hypoxia and hypothermia [3, 7]. Work in the writers' laboratory has shown that the specific musculature is not a static conducting system but contracts automatically, and through the intermediary of a functional synapse it influences the contractions of the ventricular myocardium [1, 5, 6, 9]. If anatomical connections are preserved between the atria and the atrio-ventricular system, in response to injection of certain pharmacological agents that system may contract automatically at a frequency which may exceed that of atrial contraction [8].

The object of this investigation was to study automatic contractions of the specific ventricular muscle after removal of the sinus node and auricles and interruption of its functional connection with the ventricular myocardium.

EXPERIMENTAL METHOD

The heart was removed from 23 male chinchilla rabbits weighing 2.5-3 kg under pentobarbital anesthesia (30 mg/kg). To expose the left branch of the bundle of His the wall of the left ventricle was divided between two papillary muscles. The sinus node and auricles were removed. The resulting preparation was perfused through the aorta with oxygenated Ringer's solution at 38°C. Interruption of the functional connection between the specific musculature and the ventricular myocardium was produced by stopping the perfusion for 1.5-3 h. On resumption of the perfusion the myocardium did not contract but the specific ventricular muscle exhibited contractile activity. Both before the end of perfusion (10 experiments) and after its resumption (13 experiments), at 10-min intervals the following substances were injected into the coronary vessels in the order given: acetylcholine (0.3 ml of a 2% solution), adrenaline (0.3 ml of a 0.1% solution), potassium chloride (1 ml of a 10% solution), calcium chloride (1 ml of a 10% solution) or magnesium chloride (0.5 ml of a 10% solution), strophanthin (0.3 ml of a 0.05% solution), novocainamide (0.5 ml of a 10% solution), and caffeine (0.3 ml of a 20% solution). Besides observations on contractions of the left branch of the bun-

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TABLE 1. Changes in Frequency of Contraction of the Specific Muscle of the Ventricles after Injection of Pharmacological Agents

Substance injected	Functional connection between specific muscle and myocardium of ventricles intact			Functional connection of specific muscle with myocardium interrupted		
	initial rate of contraction	5 min after injection of substance	P	initial rate of contraction	5 min after injection of substance	P
Acetylcholine	63	42	<0,01	41	31	<0,05
Adrenalin	53	101	<0,001	55	74	<0,05
Potassium chloride	96	62	<0,02	80	39	<0,01
Calcium chloride	71	64	<0,5	54	67	>0,5
Magnessium chloride	75	60	<0,5	51	50	>0,5
Strophanthin	72	72	<0,5	56	51	<0,5
Novocainamide	58	62	<0,5	56	63	<0,2
Caffeine	63	65	<0,5	57	54	<0,5

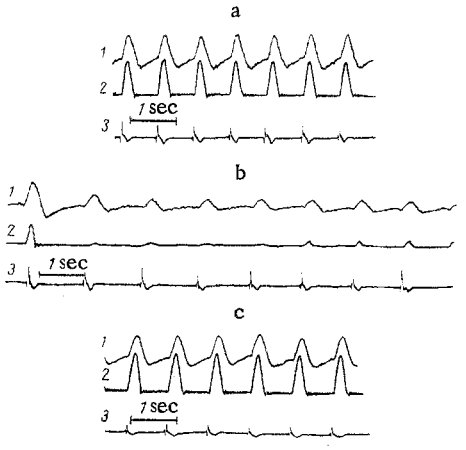

Fig. 1. Action of novocainamide on specific muscle and myocardium of ventricles: a) before injection of novocainamide; b) during injection, c) 10 min after injection of novocainamide; 1) mechanical activity of left branch of bundle of His; 2) mechanical activity of myocardium of left ventricle; 3) electrical activity in left branch of bundle of His.

dle of His (MBS microscope, 16-32×) its electrical activity and mechanical contractions were recorded from its surface [4] on an N-700 oscilloscope. Meanwhile the mechanical activity of the divided wall of the left ventricle was recorded at the level of the papillary muscles by means of a strain gauge (resistance 150Ω) connected with a TU6M-004 amplifier. An essential condition of the experiment was initial synchronization of contraction of all secondary branches of the main left branch of the bundle of His.

EXPERIMENTAL RESULTS

If functional connections were maintained between the specific muscle and the myocardium of the ventricles the initial action of acetylcholine and potassium chloride was to inhibit contractile activity of the specific ventricular muscle (Table 1). The contractile activity of the ventricular myocardium also was depressed. The response of the specific muscle and myocardium to injection of novocainamide was not always the same: in some experiments myocardial arrest took place while electrical and mechanical activity of the specific muscle continued (Fig. 1). The response to adrenalin varied in different experiments (arrest, quickening, and slowing of the contractions). An increased rate of contraction of the specific muscle after injection of strophanthin and caffeine occurred more often than a decrease ($P < 0.05$). The ventricular myocardium contracted at the same rate as the specific muscle.

After interruption of functional connection between the specific muscle and the myocardium of the ventricles and resumption of perfusion the original rate of contractions of the specific muscle was slower because of the effect of anoxia and hypothermia. However, the ability of the specific muscle to change its frequency and strength of contraction in response to injection of the test drugs was fully maintained. An increase in the strength of contractions was observed after the injection of adrenalin and calcium chloride and weakening of the contractions after injection of potassium chloride and magnesium chloride. These substances had similar effects on the specific muscle when its functional connection with the myocardium was preserved.

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