AO thus abolishes autonomic disturbances induced by EPS by normalizing BP values during function testing, preventing hypertrophy of the heart and also normalizing CCO activity in parts of the brain when increased in experimental neurosis. The results suggest that the molecular mechanism of the pathogenesis of neurosis is based on activation of LPO.

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CORRELATION BETWEEN CARDIAC ARRHYTHMIAS IN ACUTE MYOCARDIAL ISCHEMIA AND ACTIVITY OF CERTAIN STRUCTURES OF THE LIMBIC AND NORADRENERGIC SYSTEMS

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Negative emotional overstrain can give rise to a disturbance of the cardiac rhythm [2, 6-12]. It has been shown [5] that hyperactivation of a structure of the limbic system, namely the anterior amygdaloid nucleus, by the creation of a generator of pathologically enhanced excitation in it [4], can lead to disturbance of the cardiac rhythm.

In this investigation changes in electrical activity (EA) in the limbic structures of the brain after ligation of the coronary artery were studied and the effect of coagulation of these structures are changes in cardiac activity in acute myocardial ischemia (MI) was determined. Considering connections between adrenergic and limbic structures [14, 16-18], the role of the locus coeruleus (LC) in these processes also was investigated.

EXPERIMENTAL METHOD

Experiments were carried out on 90 noninbred male rats weighing 160-200 g under pentobarbital anesthesia (40 mg/kg). After preliminary immobilization (succinylcholine 0.2 mg/kg) and artificial ventilation, total bilateral electrical coagulation of the caudal and rostral regions of the hippocampus, the ventromedial and posterior hypothalamus, amygdala, and LC was carried out in accordance with stereotaxic atlases [13, 15] on the animals of group 1 (42 experiments, seven animals in each series). A current of 5 mA was passed for 15-20 sec for coagulation. Immediately after coagulation high ligation of the anterior left

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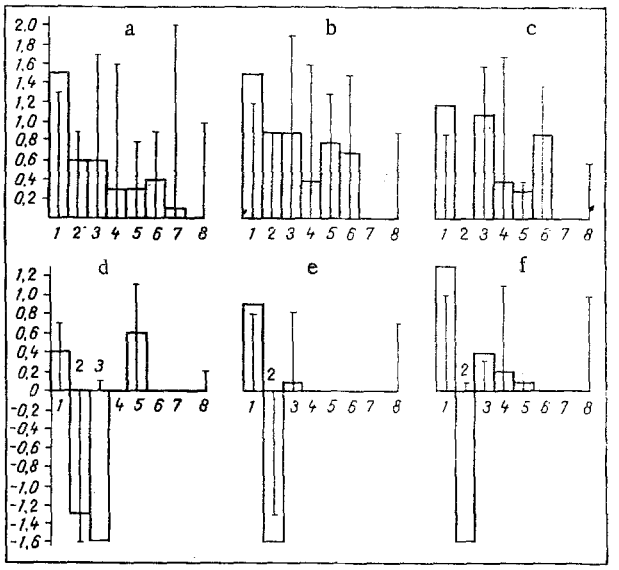

Fig. 1. Disturbances of cardiac rhythm after high ligation of left coronary artery in control animals (a) and after electrical coagulation of caudal (b) and rostral (c) regions of hippocampus, LC (d), amygdala (e), and ventromedial and posterial hypothalamus (f). 1) Single ventricular extrasystoles, 2) grouped ventricular extrasystoles, 3) sinus tachycardia, 4) paroxysmal ventricular tachysystole, 5) nodal rhythm, 6) allorhythmia, 7) ventricular fibrillation, 8) period during which cardiac arrhythmias were observed (log τ, min). Columns indicate log n (mean number of cases of one form of cardiac arrythmia); vertical lines denote time (log t, sec) during which this particular form of distrubance was observed.

coronary artery was carried out. The ECG was recorded in three standard leads by means of a cardiopolygraph and "Bioscript" instrument. High ligation of the left coronary artery was performed on animals of the control group without damage to the brain structures specified. Animals of group 2 (48 experiments, eight animals in each series) underwent preliminary implantation of electrodes (diameter of tip 150 μ) into the anterior amygdaloid nucleus, the dorsomedial, ventromedial, and posterior hypothalamic nuclei, the hippocampus, and LC.

EA of the animals was recorded 3 min after ligation of the anterior descending coronary artery. The product of momentary values of frequency (f) and amplitude (V) for a definite time interval (parameter L) was chosen as the parameter for evaluation of EA [3]. This parameter is very sensitive in low-intensity transitional processes and is suitable for the study of the rapid dynamics of the encephalogram [3]. Recorded EA was led to an analyzer (at the output of an integrator with automatic data sampling) and every 2-sec period was averaged by a frequency meter. As the initial background, the averaged number of pulses in 6 sec before development of the cardiac arrhythmia was used. The degree of significance was determined by Student's t test and by the Wald–Wolfovitz nonparametric sequential test [1], where $P \leq 0.025$. The location of the electrodes and degree of coagulation were verified histologically after each experiment.

EXPERIMENTAL RESULTS

Ligation of the coronary artery in the control animals usually led to various disturbances of cardiac activity after 5 min. The most marked and frequent forms of cardiac arrhythmias were sinus tachycardia, single and grouped ventricular extrasystoles, allorhythmia, nodal rhythm, paroxysmal ventricular tachysystole, and ventricular fibrillation (Table 1, Fig. 1a). The total period during which arrhythmias were observed averaged 12 ± 0.6 min.

Preliminary coagulation of the above-mentioned brain structures prevented the development of ventricular fibrillation after ligation of the coronary artery. Coagulation of the caudal region of the hippocampus had the most favorable effect on the course of acute MI. In this case the increase in the mean number or duration of the various disturbances of the

TABLE 1. Character of Cardiac Arrhythmias after High Ligation of Left Coronary Artery Accompanied by Coagulation of Certain Brain Structures

Arrhythmia	Coagulation of					Control
	caudal region of hippocampus	rostral region of hippocampus	L. C	amgydala	hypothalamus	
SVES						
n	37±3,8	19±1,8*	3±0,6*	8±0,6*	25±1,6*	35±1,2
t	17±1,3*	9±1,1*	1,5±0,3*	7±0,6*	12±0,6*	22±1,1
GVES						
n	9±0,7*	—	0,2±0,2*	0,5±0,3*	0,5±0,3*	5±0,7
t	10±2,0*	—	0,4±0,3*	0,2±0,2*	1,2±0,6*	9±1,1
ST						
n	10±0,9*	15±0,4*	0,4±0,3*	1,2±0,8*	2,7±0,5*	5±0,8
t	90±11*	43±1,8*	1,5±0,8*	7±0,7*	2±0,4*	55±4,2
PVT						
n	3±0,5*	3±0,4	—	—	1,7±0,3	2±0,3
t	40±2,1*	58±3,8	—	—	15±1,4*	50±1,1
NR						
n	7±0,6*	2±0,5	5±0,7*	—	1,2±0,3	2±0,4
t	25±3,0*	3±0,6*	25±2,6*	—	4,5±5,6*	7±0,7
All						
n	6±0,5*	10±0,9*	—	—	—	2,5±0,7
t	32±2,5*	37±1,8*	—	—	—	9±1,0
Fib						
n	—	—	—	—	—	1,5±0,2
t	—	—	—	—	—	120±4,7
τ, min	9±0,8*	5±0,4*	1,7±0,3*	6±0,6*	11±1,1	12±0,6

Legend. SVES) Single ventricular extrasystoles; GVES) grouped ventricular extrasystoles; ST) sinus tachycardia; PVT) paroxysmal ventricular tachysystole; NR) nodal rhythm; All) allorhythmia; Fib) fibrillation; n) number of cases of arrhythmia (mean of total number of observations); t) time (in sec) during which arrhythmias were observed; τ) total period, in min, during which cardiac arrhythmias were detected. *P < 0.05.

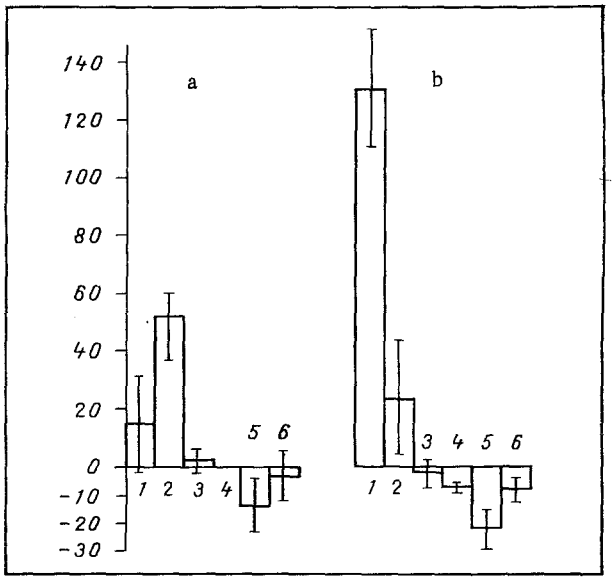

Fig. 2. Changes in EA during 4 sec (a) and 2 sec (b) before appearance of cardiac arrhythmias. Averaged values of changes in EA (parameter L) in LC (1), hippocampus (2), ventromedial hypothalamic nucleus (3), dorsomedial hypothalamic nucleus (4), anterior amygdaloid nucleus (5), and posterior hypothalamic nucleus (6).

the cardiac rhythm was particularly marked (Fig. 1b). Electrical coagulation of the posterior and ventromedial hypothalamus did not lead to any significant decrease in the period of cardiac arrhythmia (Fig. 1f).

After coagulation of the amygdala and LC acute MI did not cause paroxysmal ventricular tachysystole or allorhythmia (Fig. 1d, e). Under these circumstances a considerable reduction was observed in the number and duration of single and grouped ventricular extrasystoles, and also of sinus tachycardia. The total reduction in the number of cardiac arrhthmias was combined with a marked increase in the period of their occurrence, especially after coagulation of LC.

EA, as shown by the results of analysis of the parameter L during the chosen periods of observation showed no significant changes in any of the nuclei studied ($P > 0.025$; Fig. 2a). EA in the anterior amygdaloid nucleus and LC was an exception (Fig. 2b). In the 2 sec before appearance of the cardiac arrhythmia it increased considerably in LC (130 ± 9.8 spikes; $P - 0.025$) and decreased significantly in the anterior amygdaloid nucleus (-21.7 ± 3.0 spikes; $P = 0.025$).

Experiments with electrical coagulation thus demonstrated the different roles of structures of the limbic system and LC in the genesis and development of various forms of cardiac arrhythmia associated with acute MI. The results of these experiments agree to a larger extent with those of experiments to study EA of different nuclei, which showed that immediately before the onset of arrhythmias (in the course of 2 sec) the clearest changes took place in EA in the anterior amygdaloid nucleus and LC. The considerable decrease in disturbances of the cardiac rhythm after coagulation of the amygdala and LC and the significant changes in their EA before development of arrhythmias suggest that these formations are directly involved in the disturbance of the cardiac rhythm. It can be tentatively suggested that LC requires the role of hyperactive determinant structure [4] in this form of pathology of cardiac activity. It is also possible that inhibition of EA in the anterior amygdaloid nucleus is causatively linked with hyperactivation of LC in acute MI.

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