CHANGES IN THE SYSTEMIC HEMODYNAMICS IN DOGS WITH ADRENAL HYPERTENSION

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UDC 616.12-008.331.1-02:616.45

Arterial hypertension was produced in 20 dogs by ligation of the adrenals. Two weeks later the arterial pressure was significantly raised, the cardiac output was reduced, and the total peripheral resistance was sharply increased. The phasic syndrome of hypodynamia, the decrease in the index of contractility, in the volume velocity of blood ejection, the cardiac index, and the rate of rise of the intraventricular pressure indicated weakening of contractility of the myocardium. Three months after ligation of the adrenals the arterial pressure was raised still more and the hemodynamic shifts were similar to those of the second week of hypertension.
KEY WORDS: hemodynamics; hypertension; adrenals.

The role of the adrenals in the pathogenesis of the different types of arterial hypertension is well known [2, 6, 7], and experimental adrenal hypertension is one of the successful models of essential hypertension [2, 3, 8]. Among the many different experimental models of adrenal hypertension, the writer's attention was attracted to the method of ligation of the adrenals, which causes chronic mechanical stimulation of the glands [4, 5]. The hemodynamic characteristics of this model have not been described in the literature, and the investigation described below was accordingly undertaken.

EXPERIMENTAL METHOD

Both adrenals of 20 male dogs were ligated around the outer border with No. 6 silk thread. The cardiodynamics and hemodynamics were investigated in intact dogs and 2 weeks and 3 months after ligation of the adrenals. The mean arterial pressure was recorded by a mercury manometer introduced into the femoral artery, the polycardiogram was recorded on the 6-NEK-3 electrocardiograph, the minute and systolic volume by the thermodilution method, the pressure in the left ventricle by means of a BM-101 electromanometer, and the first derivative of the pressure through a different circuit. The specific peripheral vascular resistance, cardiac and systolic indices, indices of the minute and stroke work of the left ventricle, mean volume velocity of ejection of blood, the index of myocardial contractility, the "contraction–time" index, and the phasic and intrasystolic indices of the cardiac cycle were calculated.

EXPERIMENTAL RESULTS

The investigations showed that 2 weeks after ligation of the adrenals the mean arterial pressure of the dogs was increased (Table 1). The heart rate was unchanged. The pressure was increased as a result of a sharp rise in the vascular resistance, whereas the cardiac index was not reduced. The maximal intraventricular pressure was raised, but the pressure developed toward the end of the phase of isometric contraction was lowered. The increase in the intraventricular pressure thus continued into the period of expulsion of blood from the heart. These results point to weakening of the contractile power of the myocardium of the left ventricle. This conclusion was confirmed by the tendency for a decrease in the index of contractility [15], the first derivative of pressure (dp/dt_{max}), and the volume velocity of blood ejection. A reflection of the sharply increased resistance to the expulsion of blood was an increase in the work index of the left ventricle, which was accompanied by a significant increase in the expenditure of energy per liter of minute volume. Further evidence in support of this conclusion was given by the increase in the "contraction–time" index, which indirectly reflects an increase in the oxygen consumption of the heart [13].

In the phase structure of the cardiac cycle clearly identifiable signs of a syndrome of cardiac hypodynamia were observed (lengthening of the phase of isometric contraction, shortening of the expulsion period, a decrease

Department of Pathological Physiology, Rostov Medical Institute. (Presented by Academician of the Academy of Medical Sciences of the USSR A. M. Chernukh.) Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 84, No. 11, pp. 537-539, November, 1977. Original article submitted January 14, 1977.

TABLE 1. Changes in Indices of Systematic Hemodynamics in Dogs after Ligation of Adrenals

Indices	Background	Time of investigation	
		after 2 weeks	after 3 months
Mean arterial pressure, mm Hg	138,50±0,75	166,10±3,16*	170,30±3,38*
Heart rate, beats/min	111,68±3,48	114,00±4,51	138,11±6,65*
Cardiac index, liters/m²	1,19±0,02	1,12±0,02*	0,99±0,07*
Systolic index, ml/m²	11,42±0,57	11,04±0,71	8,82±0,62*
Specific peripheral resistance, dynes·sec·cm^{-5}/m²	8073,06±192,88	10108.63±643,28*	11737,18±441,94*
Maximal pressure in left ventricle, mm Hg	167,76±4,32	189,48±3,15*	189,43±1,66*
Final isometric pressure in ventricle, mm Hg	163,02±2,44	147,09±1,57*	150,53±2,27*
Final diastolic pressure in left ventricle, mm Hg	3,81±0,26	3,49±0,15	5,44±1,23
Work index of left ventricle, kg·m/m²	1,92±0,05	2,65±0,22*	2,64±0,13*
Stroke work index of left ventricle, g·m/m²	17,31±1,07	22,83±1,85*	21,13±1,49*
Volume velocity of blood ejection, ml/sec	124,74±7,55	110,81±9,04	76,32±4,00*
	17,32±0,75	15,81±0,88	16,88±0,56
Contractility index, dp/dt_{max}, mm Hg/sec	2895,65±98,87	2703,00±107,39	2541,10±147,78
"Contraction–time" index, mm Hg/sec	3279,29±118,26	3444,44±149,63	4085,84±231,16*
Energy expenditure per liter minute volume, W·sec/liter	18,88±0,19	22,17±0,63*	22,06±0,47*

* $P < 0.05$ compared with background.

TABLE 2. Changes in Phase Structure of Cycle of Left Ventricle in Dogs after Ligation of Adrenals (M ± m)

Indices	Background	Time of investigation	
		after 2 weeks	after 2 months
Period of contraction, sec	0,080±0,002	0,088±0,002*	0,088±0,002*
Phase of asynchronous contraction, sec	0,044±0,002	0,035±0,003*	0,046±0,002*
Phase of isometric contraction, sec	0,036±0,002	0,048±0,002*	0,042±0,0001*
Period of expulsion, sec	0,140±0,003	0,115±0,001*	0,126±0,027
Mechanical systole, sec	0,175±0,006	0,164±0,005	0,174±0,002
Total systole, sec	0,210±0,015	0,185±0,012	0,228±0,005
Mechanical diastole, sec	0,395±0,036	0,393±0,029	0,290±0,010*
Blumberger's coefficient	1,75±0,018	1,45±0,033*	1,46±0,55*
Index of myocardial contraction, %	38,12±1,14	41,26±1,96	39,20±1,00
Intrasystolic index, %	80,20±2,26	71,31±1,22*	72,50±0,92*
Expulsion time of minute volume, sec	15,64±0,42	13,12±0,35*	18,14±0,59*

* $P < 0.05$ compared with background.

in Blumberger's coefficient), further confirmation of the weakening of myocardinal contractility (Table 2).

An even higher level of the mean arterial pressure was observed 3 months after ligation of the adrenals, but under these circumstances there was some quickening of the heart beat. The hemodynamic structure of the hypertension remained virtually unchanged: The peripheral vascular resistance was sharply increased but the cardiac output was reduced. Just as at the previous period of the investigation there were signs of weakening of myocardial contractility, but they were rather less marked. The results are thus evidence that a vascular form of hypertension develops after ligation of the adrenals. The results characterize only the hemodynamic nature of the hypertension and do not explain the mechanisms of the changes observed. Three possible mechanisms of the hemodynamic changes can be tentatively suggested. First, hypersecretion of glucocorticoids and an increase in vascular sensitivity to adrenergic influences [9, 12]. Second, hypersecretion of mineralocorticoids, leading to retention of sodium and its accumulation in the vessel wall [10]. Finally, the possibility of development of hypertension of "regeneration" type [11, 14] cannot be ruled out, for in "regeneration" hypertension the secretory activity of the adrenals is depressed [11, 14]. The third hypothetical mechanism of the changes discovered is based on the possible hypersecretion of renin in response to the reduced secretion of aldosterone. Whatever the true explanation, the hemodynamic structure of hypertension as described above

resembles changes in the hemodynamics following infusion of synthetic angiotensin-II into intact adult dogs [1].

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DEPENDENCE OF PHOSPHOLIPID METABOLISM IN VARIOUS PARTS OF THE RAT BRAIN ON THE DEGREE OF LOCAL CIRCULATORY DISTURBANCE (AFTER LIGATION OF THE CAROTID ARTERIES)

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UDC 616.831-005-07:616.831-008.939.53-074

After bilateral ligation of the common carotid arteries in rats the blood supply and phospholipid metabolism were reduced considerably in the cerebral hemispheres, to a lesser degree in the diencephalon and mesencephalon, but unchanged in the medulla and cerebellum. The dependence of the degree of depression of phospholipid metabolism on the degree of disturbance of the blood supply differed in the various parts of the brain. Restoration of the blood supply was not observed 5 h after ligation of the common carotid arteries.

KEY WORDS: cerebral ischemia; phospholipid metabolism.

Of all the cardiovascular diseases the cerebrovascular are among the commonest forms: Spasms of the cerebral vessels, and thrombosis and embolism of the brain are particularly serious. These diseases are associated with various degrees of cerebral ischemia, as a rule local; in turn, this leads to anoxia of the ischemic region of brain tissue. Elucidation of the mechanism of action of the ischemic form of cerebral anoxia on brain metabolism is an essential step to the fuller understanding of the pathogenesis of these diseases and, consequently, for their timely prevention and their rational, pathogenetically oriented treatment.

Different parts of the CNS are known to respond differently to anoxia and the duration of survival of nerve cells located at different levels of the CNS in an oxygen-free environment also differs [2, 4]. This difference is manifested in the general form as lowered resistance to anoxia of the phylogenetically younger nervous formations and the comparative resistance of the older portions of the CNS, and it is associated with definite functional, metabolic, and morphological differences between different levels of the CNS.

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Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 84, No. 11, pp. 539-541, November, 1977. Original article submitted February 24, 1977.