Changes in Gluco- and Mineralocorticoid Adrenal Functions in Spontaneously Hypertensive Rats during Experimental Myocardial Infarction

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Translated from *Byulleten' Eksperimental'noi Biologii i Meditsiny*, Vol. 129, No. 1, pp. 25-27, January, 2000
Original article submitted June 17, 1999

The dynamics of corticosterone and aldosterone contents during the acute and restoration periods of experimental myocardial infarction was studied in Wistar and spontaneously hypertensive rats. In spontaneously hypertensive rats, the increase in aldosterone concentration during the acute period was followed by elevation of corticosterone content, which attested the disadaptive course of experimental myocardial infarction against the background of hereditary arterial hypertension.

Key Words: *hormones; arterial hypertension; myocardial infarction*

It is known that hormones largely determine the formation and pathogenesis of arterial hypertension (AH) and myocardial infarction (MI) [13]. The interrelation between these diseases and their common pathogenic mechanisms were established [7]. However, the data on changes in various endocrine systems are ambiguous and do not reflect qualitative peculiarities of hormonal interrelations during AH and MI. This primarily concerns cortisol (corticosterone) and aldosterone that belong to the main stress-realizing system and are involved in the maintenance of hormonal homeostasis. Here we studied changes in the contents of corticosterone and aldosterone and hormonal interrelations in normo- and hypertensive rats during experimental myocardial infarction (EMI).

MATERIALS AND METHODS

Experiments were performed on 80 normotensive male Wistar rats weighing 180-200 g and rats with stress-induced spontaneous hypertension (SHR) obtained from the Institute of Cytology and Genetics. During stress, blood pressure (BP) in SHR was 205±2 mm Hg (*vs.* 170±2 mm Hg in the control). EMI was induced by subcutaneous injection of 0.1% epinephrine (0.2 mg/100 g body weight) and verified electrocardiographically. Ether-anesthetized rats were decapitated on days 1, 2, 3, 7, 14, and 21 of EMI, and blood samples were taken. The contents of corticosterone and aldosterone in the plasma were estimated by competitive binding and using enzyme radioimmunoassay kits (Sorin), respectively.

RESULTS

During the acute period of EMI, SHR had elevated aldosterone concentration (Table 1). The content of corticosterone, which is known to increase in stress [8], remained unchanged. This elevation of aldosterone concentration probably reflects extracardial compensation of cardiac insufficiency, which is more pronounced in SHR. During severe cardionecrosis, steroidogenesis is shifted towards the synthesis of aldosterone but not glucocorticoids [4] due to activation of the renin-angiotensin-aldosterone system (RAAS) [14]. This is consistent with the concept that cardiovascular insufficiency

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0007-4888/00/0001-19$25.00

TABLE 1. Plasma Contents of Aldosterone (nmol/liter) and Corticosterone (mg %) in Normo- and Hypertensive Rats during EMI (*M±m*)

Day	Wistar		SHR	
	A	C	A	C
1	1.12±0.2	41.4±4.3	7.5±1.3*+	46.1±3.4
2	1.17±0.3	55.7±7.2+	3.9±0.8*+	68.1±8.0+
3	1.4±0.1	42.2±3.1+	2.7±0.4*+	88.9±12.8*+
7	1.2±0.2	39.9±3.5	1.7±0.4	58.4±3.4*
14	1.2±0.2	44.3±3.8+	0.9±0.06+	63.7±7.0
21	1.0±0.2	62.9±5.1+	1.0±0.06+	58.1±6.6
Control	1.0±0.15	25.0±5.0	1.5±0.02*	40.0±5.0*

Note. *$p<0.05$ compared with Wistar rats and +$p<0.05$ compared with the control. A: aldosterone; and C: corticosterone.

determines RAAS changes during acute EMI [12]. The activation of RAAS is one of the major adaptive components of the stress response to acute coronary disturbances. This is not true for SHR, because the reaction of adrenal mineralocorticoid functions to a stress factor (EMI) disagrees with Wilder—Leites rule of the initial state [9], which postulates that if the cell, tissue, organ, or physiological system is activated, the stimulatory agent induces weak, zero, or even opposite effects, whereas the inhibitory agent causes the greatest response. Subsequent decrease in the content of aldosterone is probably due to reduced sensitivity of glomerular adrenocortical cells to activating stimuli and delayed activation of the synthesis and secretion of corticosterone (as demonstrated by the dynamics of corticosterone/aldosterone ratio). Sharp activation of the hyperplastic adrenal glands in SHR probably caused exhaustion of the glomerular zone [1]. In normotensive animals, the reaction of the adrenal cortex appeared as an increase in plasma corticosterone on day 1 of EMI. Unchanged aldosterone concentration in these animals attests to their higher resistance to stress and moderate cardiac insufficiency. The rise in plasma corticosterone in normotensive rats on day 21 of EMI corresponds to the dynamics of stress reaction [2]. The absence of such changes in SHR is similar to the dynamics of cortisol content in elderly and in patients with MI [6], which confirms the adequacy of our experimental model.

The rule of the initial state allows us to determine the directionality of changes in endocrine parameters, because without analyzing the basal content of these hormones, the dynamics of aldosterone and corticosterone concentrations looks like a primary adaptive process [3].

Mineralocorticoid function of the adrenal glands in SHR is activated in response to progressive BP decrease. However, such activation is pseudoadaptive and should be considered as adaptation disease [11]. Moreover, BP rise or normalization occurs only at the end of the restoration period and, therefore, homeostasis is restored according to the "at any rate" principle (activation of reserve mechanisms). These data confirm the idea of a qualitatively new level of the functioning of regulatory systems in arterial hypertension, when the maintenance or normalization of elevated BP is analogous to a "hyperactive determinant structure" [5].

The constellation of endocrine interrelations is considered as a manifestation of hyperadaptation in SHR, which is primarily determined by peculiarities of basal metabolism and corresponds to a disadaptive course of EMI.

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