Changes in the Resistance in Brachiocephalic Artery and Thoracic Aorta Basins during Depressor Reactions of the Circulatory System

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Acute experiments on narcotized cats with depressor shifts in the circulatory system induced by acetylcholine and histamine revealed more pronounced decrease in vascular resistance in the brachiocephalic artery in comparison with the thoracic aorta basin. Cardiac output was redistributed between these vascular basins: the bloodflow increased in the brachiocephalic artery and decreased in the thoracic aorta. Hemodynamic shifts in the arterial compartment of the vascular system are presumably essential for changes in the bloodflow in venae cavae.

Key Words: *bloodflow; brachiocephalic artery; thoracic aorta; total peripheral vascular resistance; cardiac output*

The main components of total peripheral vascular resistance (TPVR) are vascular basins supplied from the brachiocephalic artery (BCA) and thoracic aorta (TA). Venous outflow from these basins via the venae cavae forms the basic constituents of summary venous return to the heart. Study of changes in the bloodflow in venae cavae in response to exposure of the circulatory system to various neurogenous and humoral stimuli showed that bloodflow in the anterior vena cava increased, while the bloodflow in the posterior vena cava changed differently and usually coincided with the direction of shifts in arterial pressure [1,2,4,5].

This regularity manifests in pressor and depressor shifts of systemic hemodynamics. During pressor shifts in the circulatory system, vascular resistance increase to a greater extent in the TA basin than in BCA vessels. The lesser increase in the vascular resistance in BCA basin is presumably responsible for bloodflow increase in the anterior vena cava [2]. The direction of bloodflow changes in the venae cavae depends on the ratio of resistance values in the BCA and TA vascular basins (the vascular regions from which the blood flows in the anterior and posterior venae cavae, respectively) [2].

Different degree of changes in the regional TPVR resulting from pressor shifts in the circulatory system prompted evaluation of the balance of shifts in the vascular resistance of BCA and TA basins during humoral depressor shifts.

We measured the shifts in peripheral resistance of TA and BCA basins during depressor reactions of the circulatory system caused by acetylcholine and histamine, associated also with opposite changes in the bloodflow in the venae cavae (increase in the anterior and decrease in the posterior venae cavae) [3,4].

MATERIALS AND METHODS

The study was carried out on 16 cats. The animals were narcotized with nembutal (200 mg/kg), the chest was opened, 1000 U heparin was injected, and the animals were transferred to artificial ventilation with Vita-1 device.

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Systemic arterial pressure was measured in the left subclavian artery by the direct method using an EMT-34 electronic manometer (Siemens-Elema). Bloodflow values in the aortic arch (cardiac output without coronary fraction), BCA, and TA were evaluated by electromagnetic method with MFV-2100 cuff flowmeter pickups (Nihon Kohden). In order to rule out the mutual effects of electromagnetic fields of the bloodflow pickups, their work was synchronized by the time of magnetic field direction switch-over. The measured parameters were digitized in the real time mode and introduced into computation complex for filtration and further processing. The values of TPVR and its regional components in arbitrary units (mm Hg/ml/min) were calculated from recorded values of arterial pressure and volume bloodflow velocity in vessels.

Depressor shifts in the circulatory system was induced by alternating bolus injections of 0.1-1.0 μg/kg acetylcholine or 0.25-8.00 μg/kg histamine into the femoral vein at the initial mean systemic arterial pressure of no less than 90 mm Hg.

The data were statistically processed by the standard methods using Fisher—Student probability distribution.

RESULTS

Depressor shifts in the systemic circulation caused by intravenous injection of acetylcholine were accompanied by reduction of the mean values of all studied circulatory parameters in the experimental animals. Systemic blood pressure dropped by one-third, while cardiac output decreased negligibly (Table 1; Fig. 1). TPVR decreased in comparison with the basal level, while its components changed in the same direction, but to a different measure, similarly as during exposure to pressor systemic reactions. Vascular resistance in the BCA basin changed more markedly: changes in BCA surpassed the shifts in TA vessels by 762% (absolute resistance) and by 1.9 times (% of the initial level). The differences in the shifts of resistance in BCA and TA vascular basins manifested by a significant redistribution of cardiac output between these vascular regions: the bloodflow in BCA vessels increased and in TA vessels decreased in comparison with the initial level.

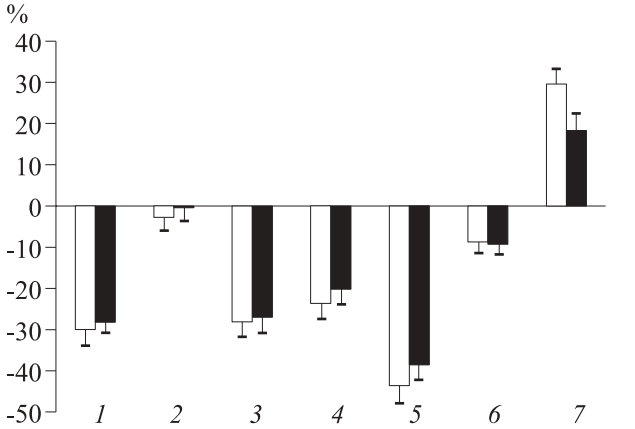

Fig. 1. Changes in systemic hemodynamic values in response to injection of acetylcholine (light bars) and histamine (dark bars). *1*) systemic arterial pressure; *2*) cardiac output; *3*) TPVR; *4*) TA vessels resistance; *5*) BCA vessels resistance; *6*) TA bloodflow; *7*) BCA bloodflow.

Histamine also induced blood pressure drop (Table 1, Fig. 1). Changes in cardiac output were different: increase in 64% and decrease in 36% cases. The mean deviation of this value from the mean level virtually did not differ from zero. TPVR decreased, its regional components also decreased, though to a different degree. The resistance in BCA basin decreased more significantly than in TA basin. Changes in vascular resistance in BCA sur-

TABLE 1. Changes in Systemic Hemodynamics in Response to Depressor Agents (*M*±*m*)

Parameter	Acetylcholine		Histamine	
	basal level	shift in experiment	basal level	shift in experiment
Systemic arterial pressure, mm Hg	114±8	-29.61±4.48	98±7	-28.18±2.71
Cardiac output, ml/min	293±23	-2.82±3.16	212±28	-0.42±3.15
TPVR, arb. units	0.41±0.04	-0.12±0.02	0.53±0.06	-0.13±0.02
Vascular resistance, arb. units				
TA	0.54±0.05	-0.14±0.03	0.65±0.09	-0.11±0.02
BCA	2.40±0.51	-1.20±0.34	2.34±0.25	-0.87±0.11
Bloodflow, ml/min				
TA	224±19	-17.92±4.69	181±28	-9.33±2.26
BCA	63±7	+15.83±13.15	49±8	+18.93±4.15

passed the shifts in TA vessels by 676% (absolute resistance) and by 1.8 times (relative values). These differences in local vascular reactions manifested also by respective redistribution of cardiac output components between the anterior and posterior parts of the body: the bloodflow in BCA increased 2-fold more intensely than in TA.

It was found that depressor hemodynamic shifts were always paralleled by more pronounced decrease in vascular resistance in BCA compared to TA basin. This led to redistribution of blood ejected by the heart between the main vascular regions providing venous return via the anterior and posterior venae cavae (BCA and TA basins, respectively), the cardiac output fraction directed to BCA increased and that directed to TA decreased. Hence, increased bloodflow in the anterior vena cava during depressor reactions of the circulatory system, similarly as during systemic pressor shifts, is due to different degree of changes in the local components of TPVR; the mechanism of this phenomenon deserves further studies.

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