EFFECT OF ISOLATION OF THE HEART FROM THE CIRCULATION ON REFLEX CHANGES OF REGIONAL VASCULAR RESISTANCE IN ISCHEMIA

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In experiments on 16 anesthetized dogs the systemic circulation and the heart were perfused separately. Myocardial ischemia, developing when the blood supply to the heart was interrupted, was accompanied by reflex vasoconstriction in the limbs, small intestine, and kidneys. It is shown that the reflex vasoconstriction is unconnected with stimulation of chemoreceptor structures in the aorta. Additional hypoxic excitation of the aortic chemoreceptors leads to changes in the magnitude and regional structure of the pressor response.

The character of reflex vasomotor responses to myocardial hypoxia has not yet been finally solved. Experimental investigations have shown that disturbance of the blood supply to the hemodynamically isolated heart is accompanied by a reflex increase in the general peripheral resistance.

The object of the present investigation was to examine the possible role of aortic chemoreceptors in the mechanism of this response. Such investigations are necessary because the aortic chemoreceptors may lie in direct proximity to the heart and may be supplied with blood from different parts of the ascending aorta or even of the coronary vessels.

EXPERIMENTAL METHOD AND RESULTS

Experiments were performed on 16 dogs anesthetized with morphine (0.0025 g/kg), chloralose (0.05 g/kg), and urethane. In all experiments a complete artificial circulation was provided with the AIK RP-64 apparatus. The heart was isolated hemodynamically from the systemic and pulmonary circulations by successive ligations of the venae cavae and azygos vein, the roots of the lungs, and the ascending part of the arch of the aorta (1-1.5 cm distially to the valves). The work of the heart and its blood supply were maintained by injecting donors' arterial blood into the left atrium under constant pressure. During the experiments simultaneous recordings were made of the perfusion pressure in the systemic circulation, the pressure in the chambers of the heart, the resistogram of blood vessels of the hind limb, small intestine, and kidneys, and the EKG in standard leads. Myocardial ischemia was produced by stopping the inflow of blood into the left atrium for 1-2.5 min.

In each experiment a control injection of lobeline, a powerful stimulant of the aortic chemoreceptors, was given in a dose of 1 mg into the blood flow of the isolated heart. The heart was regarded as isolated from chemoreceptor structures of the aortic arch if during passage of lobeline through the chambers of the left heart, the part of the aorta next to the heart, and the coronary vessels, no pressor reflex characteristic of stimulation of the aortic chemoreceptors arose in the systemic circulation. This degree of isolation of the heart was obtained in 10 of the 16 experiments (group 1). In these experiments, intracardiac injection of lobeline was accompanied by a depressor reaction analogous to the Bezold–Jarisch effect which develops in response to stimulation of the receptors of the heart itself.

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TABLE 1. Magnitude of Pressor Responses during Interruption of Blood Supply to the Hemodynamically Isolated Heart (in percent of initial level of perfusion pressure) (M ± m)

	General perfusion pressure	Vessels of hind limb	Vessels of small intestine	Renal vessels
Group 1	12,2–1,8 (24)	11,3–1,6 (23)	10,2–1,4 (11)	5,4–2,2 (12)
Group 2	27,5–1,3 (18)	15,8–2,4 (18)	61,0–14,6 (8)	33,0–10,7 (6)
P	<0,01	>0,05	<0,01	<0,05

Note. Number of observations shown in parentheses.

In 6 experiments (group 2), injection of lobeline into the heart led to a pressor reflex which, in the writer's opinion, was evidence of the partial or complete blood supply of the aortic chemoreceptors from the part of the aorta next to the heart.

In all 16 experiments, cessation of the blood supply to the heart was accompanied by a sharp decrease of intraventricular pressure, the appearance of signs of myocardial ischemia on the EKG, and a reflex increase in the perfusion pressure and vasoconstriction of the bascular regions investigated. However, the character, magnitude, and regional components of the pressor response differed significantly among animals of groups 1 and 2 (Table 1).

In the experiments of group 1, the general perfusion pressure and the vascular tone in the regions of the circulation were increased at the beginning of the response and were maintained at this high level throughout the period of interruption of blood supply to the heart. Vasoconstriction was strongest in the limbs.

In the experiments of group 2, the pressor response of the general perfusion pressure was twice as great as in group 1. Vasoconstriction was strongest in the vessels of the intestine and weakest in the limb vessels (Table 1), and the degree of vasoconstriction gradually increased in the course of the response.

The vasomotor responses in 10 experiments of group 1 were interpreted as the result of reflex effects from the receptor zone of the heart; they could be due to weakening of the inflow of afferent impulses from the heart through a decrease in mechanical activity and stimulation of the receptors of the heart as a result of myocardial ischemia.

The more marked and prolonged vasoconstrictor effect in the experiments of group 2 was evidently due to summation of the reflex arising directly from the receptors of the heart with reflex influences in response to increasing hypoxia of the aortic chemoreceptors. From this point of view, differences in the character and magnitude of reflex vascular responses in the experiments of groups 1 and 2 may provide evidence of the relative roles of the receptors of the heart and chemoreceptors of the aorta in the vasomotor changes arising in hypoxic states.