REFLEX CHANGES IN VENOUS TONE

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Results are described which indicate a definite increase in tone of both arteries and veins of the limb after stimulation of the lumbar sympathetic chain or afferent fibers of the tibial nerve and during compression of the carotid arteries. The degrees of the changes in tone of the arteries and veins of the limb relative to the magnitude of responses of these vessels to the maximally effective frequencies of stimulation of the lumbar sympathetic chain was slightly greater in the veins in these particular cardiovascular reflex responses.

The principal functions of the reservoir vessels are to regulate the circulating blood volume and to establish and maintain an adequate blood supply to the heart, i.e., to maintain the systemic and not the local circulation. These special features of the function of these veins largely determine the character of regulation of their lumen [8, 11, 16]. Many workers have described definite differences in the responses of reservoir and resistive vessels to direct stimulation of peripheral sympathetic fibers and to intravascular injection to catecholamines [11, 16], to the accumulation of locally formed metabolites in the tissues [7, 10, 15], to physical exertion [16], and to complex adaptive changes in cardiovascular function associated with the action of various stimuli on the body [1-3, 8].

Investigations both confirming [9, 11] and questioning [4, 5] the role of veins in the development of cardiovascular reflexes have been described. This problem is fully and critically analyzed in the survey by Mellander [12]. The view is held that differences in the effector responses of successive vascular sections are connected with local factors such as the number of sympathetic nerve endings in the vessel wall, and sensitivity to mediators and to locally formed metabolites [11, 13, 14]. Folkov and Mellander [6] point out that most stimuli evoking changes in sympathetic influences on resistive vessels also have an action, similar in direction but different in magnitude, on the reservoir part of the cardiovascular system. On the basis of the existing data it is evidently too early to draw any definite conclusions regarding the uniformity of sympathetic influences on resistive and reservoir vessels.

The object of the present investigation was to compare changes in tone of the arterial and venous portions of the cardiovascular system in the course of certain reflexes.

EXPERIMENTAL METHOD

Acute experiments were carried out on 15 cats under nembutal (40 mg/kg, intraperitoneally) anesthesia. The role of the resistive and reservoir blood vessels of the limb in generalized cardiovascular reflexes to direct stimulation of sympathetic fibers and to changes in sympathetic activity arising as reflex responses to a lowering of pressure in the carotid sinuses and stimulation of sensory fibers of the tibial nerve was investigated.

Arterial and venous tone in the limb was recorded by an occlusion method, first used by Hooker [7] and slightly modified by Bartelstone [2]. The principle of the method is that when the circulation of blood

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in an individual organ or limb is arrested, the pumping and suction effect of the heart on the filling of the blood vessels in that part is excluded; the intravascular blood volume remains constant, and the intravascular pressure reflects the tone of the vessel wall.

In the investigations now carried out, the blood volume in the lower part of the trunk was stabilized by clamping the aorta and inferior vena cava distally to the origin of the renal vessels. The pressure in the femoral arteries and vein and the systemic arterial pressure were recorded by means of tensometric transducers connected to a multiple-point ÉPP-09 potentiometer. The interval between individual tests was not less than 5 min, quite long enough for the normal conditions of the circulation to be restored.

EXPERIMENTAL RESULTS

Clamping the abdominal aorta and inferior vena cava was accompanied by elevation of the systemic arterial pressure (SAP) on the average by 12-15 mm Hg. The pressure in the femoral artery fell on the average by 90-100 mm Hg to 20-25 mm Hg. The pressure in the femoral vein rose by 15-30 mm water to 70-80 mm water. During the first minute of stimulation, as a rule the pressures in the femoral artery and veins were stabilized; against this background additional stimuli were applied and their action on the tone of the resistive and reservoir vessels of the limb was investigated.

Stimulation of the lumbar sympathetic chain at the level L_4-L_5 (10/sec, 8-10 V, 1-2 msec) led to an increase in the SAP (on the average by 17%) and in the pressure in the femoral veins (by 45%) and the femoral arteries (by 175%).

Electrical stimulation of the central end of the divided femoral nerve (50/sec, 10 V, 1-2 msec) was accompanied by elevation of the SAP on the average by 13%, and by an increase in the pressure in the femoral veins by 25% and in the femoral arteries by 50%.

Compression of both carotid arteries raised the SAP on the average by 22%, and increased the pressure in the femoral veins by 39% and in the femoral arteries by 96%.

Cessation of stimulation in all three series of experiments was accompanied by a decrease in both the SAP and in the pressure in the femoral arteries and veins approximately to the level observed before stimulation. After removal of the clamps from the abdominal aorta and inferior vena cava, the pressure in all investigated regions returned to its initial level in the course of 1-2 min.

Despite the fact that the method used can give a quantitative estimate of the response of the reservoir and resistive vessels to various stimuli, it is difficult to compare the estimates of these serially connected vascular sections, because the initial background differed sharply from normal. Nevertheless, by comparing the responses of the arteries and veins to reflex stimulation with responses arising to the most effective frequencies of stimulation of the sympathetic fibers, it is possible to assess the degree of involvement of the resistive and reservoir vessels of the limb in the reflex responses and to indicate the character and magnitude of changes in the flow of sympathetic impulses in fibers supplying the vessels.

The results described demonstrate that lowering the pressure in the carotid sinuses, as well as stimulation of afferent fibers of the tibial nerve, lead to a marked increase in sympathetic activity in nerves supplying the arteries and veins of the limb, manifested by a considerably increase in their tone. During the development of a pressor response to stimulation of the sensory fibers of the tibial nerve, the response of the resistive vessels reached 29%, and that of the reservoir vessels 54%, of the magnitude of responses to maximally effective frequencies of stimulation of the lumbar sympathetic chain, while during the development of a pressor carotid sinus reflex the corresponding figures were 55 and 85%. Further investigations still show whether this difference in the responses is due to a selective increase in activity in the fibers running to one of the successive vascular sections, or whether it was due to the action of local factors.

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