NERVOUS REGULATION OF THE TONE OF THE CORONARY VESSELS

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The view has been expressed that the tone of the coronary vessels is not under nervous influences [7, 15, 16]. Meanwhile, many facts demonstrate the existence of nervous control of the coronary vessels. Most investigators believe that the coronary vessels possess a definite vasomotor tone [6], maintained by vasomotor influences transmitted along the sympathetic nerves [3, 17, 18].

It is difficult to form a definite conclusion regarding the participation of the vagus nerves in the transmission of vasomotor influences to the coronary vessels because of the extremely contradictory nature of the data in the literature. Nor is the problem of the reflex regulation of the coronary circulation any more clearly understood.

The many contradictory data concerning the nervous regulation of the tone of the coronary vessels are due primarily to the use of different and frequently inadequate techniques for its investigation. Most authors have used the method of measurements of the volume velocity of the coronary blood flow, although it cannot differentiate between active reactions of the coronary vessels and passive reactions associated with concomitant changes in the systemic arterial pressure, the strength and frequency of the cardiac contractions, and so on.

The object of the present investigation was to study the character of the reaction of the coronary vessels to stimulation of the efferent fibers of the vagus nerve and to discover the degree of participation of the coronary vessels in the systemic vasomotor reflexes evoked by stimulation of the receptors of the carotid sinuses and the central ends of the divided vagus and sciatic nerves.

EXPERIMENTAL METHOD

Experiments were carried out on 14 noninbred dogs weighing 5-15 kg under chloralose anesthesia (100 mg/kg body weight, intravenously). The thorax was opened in the fourth left intercostal space under controlled respiration. The descending branch of the left coronary artery was dissected; its peripheral end was connected with the outlet pipe of a pump giving constant output (a resistograph). The inlet pipe of the pump was connected to the central end of the carotid or femoral artery. In experiments to stimulate the efferent fibers of the vagus nerve, leading to a sharp fall in the systemic arterial pressure and, consequently, of the pressure in the inlet pipe of the pump, the latter was connected to the artery of a donor dog and the coronary artery was perfused throughout the experiment with donor's blood. The equivalent volume of blood was returned from the femoral artery of the experimental animals to the donor's vein by means of a second pump. To prevent the blood from clotting, heparin was injected.

The perfusion pressure in the descending branch of the left coronary artery and, in some experiments, in the femoral artery also was recorded in step with the systemic arterial pressure. Depending on the character of the changes in perfusion pressure when the perfusion was carried out in constant inflow conditions, changes in the tone of the vessels in the investigated regions could be estimated [5].

Carotid sinus vascular reflexes were evoked by an increase or decrease in the perfusion pressure in the carotid artery. The nerves were stimulated by rectangular pulses of current with a frequency of 50 cps, pulse duration 10 msec, and voltage 0.1-2 V, in the case of stimulation of the vagus nerve, and 7-10 V in the case of stimulation of the sciatic nerve.

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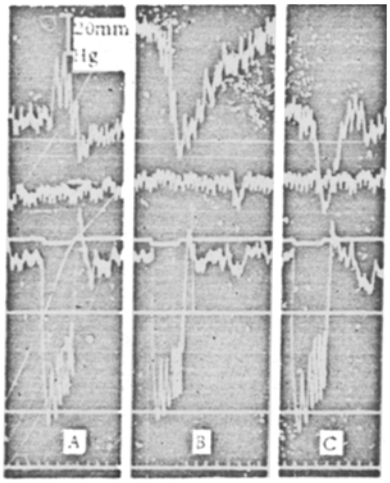

Fig. 1. Reactions of the coronary vessels to stimulation of the efferent fibers of the vagus nerve by an electric current of voltage 2 V in the presence of adequate (A, C) and an increased (B) volume of perfusion of the descending branch of the left coronary artery with donor's blood. From top to bottom: perfusion pressure in coronary artery; donor's blood pressure; marker of stimulation; blood pressure of experimental dog; zero line of perfusion pressure in coronary artery; zero line of donor's blood pressure; zero line of blood pressure of experimental dog; time marker 10 sec.

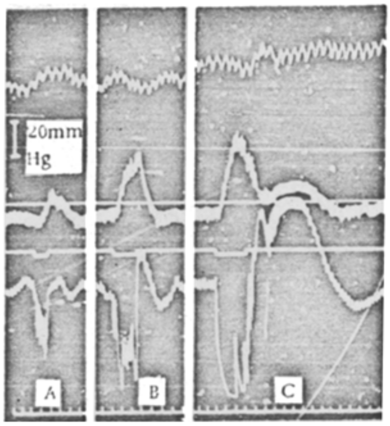

Fig. 2. Reactions of the coronary vessels to stimulation of the efferent fibers of the vagus nerve by an electric current of voltage 0.1 V (A), 0.5 V (B), and 0.7 V (C). From top to bottom: donor's blood pressure; its zero line; perfusion pressure in the coronary artery; marker of stimulation; blood pressure of the experimental dog; zero line of perfusion pressure in the coronary artery; time marker 10 sec.

EXPERIMENTAL RESULTS AND DISCUSSION

Stimulation of the peripheral end of the divided vagus nerve always led to changes in the tone of the coronary vessels. However, these changes were inconstant. Most commonly dilatation of the coronary vessels was observed, but occasionally constriction or a biphasic reaction was seen.

The experimental results showed that the vagus nerve may exert both vasoconstrictor and vasodilator influences on the coronary vessels. However, an explanation was required of the mechanisms responsible for the direction of the reaction of the coronary vessels during stimulation of the peripheral end of the divided vagus nerve.

Comparison of Fig. 1, A and B, illustrating the effect of successive stimulation of the peripheral end of the vagus nerve in the same experiment, shows that stimulation of equal strength produced identical changes in the cardiac activity, but changes of different direction in the perfusion pressure in the coronary artery. This supports the view that the changes in perfusion pressure in the coronary artery during stimulation of the efferent fibers of the vagus are primarily the result of changes in the tone of the coronary vessels and are not connected with changes in the activity of the heart. The same figure demonstrates an attempt to discover the relationship between the direction of the reaction of the coronary vessels to stimulation of the efferent fibers of the vagus nerve and the height of the initial perfusion pressure in the coronary artery, itself connected with the level of the minute volume of perfusion. In the presence of an adequate perfusion pressure (Fig. 1, A) stimulation of the vagus nerve caused a pressor reaction of the coronary vessels, whereas the same stimulation against the background of a perfusion pressure raised by 50 mm Hg led to dilatation of the coronary vessels (Fig. 1, B). However, the next stimulation, carried out at the initial perfusion pressure (Fig. 1, C), was accompanied not by constriction, but again by dilatation of the coronary vessels.

Hence, neither in this nor in other analogous experiments could a relationship be established between the direction of the reactions of the coronary vessels to stimulation of the efferent fibers of the vagus nerve and the level of the initial volume of perfusion of the coronary artery.

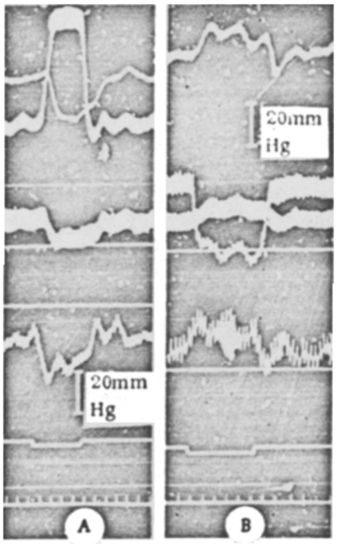

Fig. 3. Reactions of the coronary vessels during depressor (A) and pressor (B) carotid-sinus reflexes. From top to bottom: perfusion pressure in femoral artery; perfusion pressure in carotid sinus; perfusion pressure in coronary artery; systemic arterial pressure. The straight lines, the marker of stimulation, and the time marker correspond to the zero lines of the manometers.

An attempt was also made to discover a relationship between the direction of the reactions of the coronary vessels and the strength of stimulation applied. The results of one such experiment are shown in Fig. 2. Comparison of the fragments A, B, and C shows that an increase in the voltage of the stimulating current from 0.1 V to 0.5 and 0.7 V strengthened the vasoconstrictor influence on the coronary blood vessels, but the direction of the reaction remained unchanged.

These results do not reveal why stimulation of the efferent fibers of the vagus nerve caused sometimes dilatation, sometimes constriction, and sometimes a biphasic reaction of the coronary vessels. All that can be said is that the course of the reaction of the coronary vessels in one direction or another was independent of the initial volume of perfusion and of the strength of the stimulation applied.

The question of the participation of the coronary vessels in systematic reflex vascular reactions is no less complex.

During a pressor carotid-sinus reflex evoked by compression of the coronary arteries, some authors have observed an increase in the coronary blood flow [10], while others have observed different reactions: usually an increase, less commonly a decrease [12].

During a depressor carotid-sinus reflex the coronary blood flow, according to some investigators, is increased [14], but according to others [13] it is decreased. In experiments on a heart-lung-head preparation [2, 19] a decrease in the coronary blood flow was observed. As a whole however, these results cannot be used to solve the problem of the degree to which the coronary vessels participate in carotid-sinus reflexes. Only the experiments of N. V. Kaverina [3] showed that during autoperfusion of the coronary artery at a constant minute volume the coronary vessels were constricted during the pressor carotid-sinus reflex. The results of the present experiment showed that during a depressor carotid-sinus reflex the coronary vessels were clearly dilated (Fig. 3, A), and during a pressor reflex they were constricted (Fig. 3, B).

The data for the changes in the coronary blood flow during stimulation of the afferent fibers of the somatic nerves are also contradictory [1, 4, 8, 9].

In the present experiments stimulation of the central end of the divided sciatic nerve led to an increase in the perfusion pressure in the coronary artery, evidence of constriction of the coronary vessels. Similar results were obtained previously by N. V. Kaverina [3] during stimulation of the tibial and median nerves. During stimulation of the central end of the vagus nerve, various authors have observed sometimes inconstant variations in the coronary blood flow [8, 9], sometimes an increase [10], and sometimes a decrease [11].

In the present experiments stimulation of the central end of the divided vagus nerve led to inconstant changes in the tone of the coronary blood vessels. In cases when the systemic reaction of the blood pressure was depressor, the coronary vessels were dilated. During stronger stimulation of the vagus nerve, when the systemic reaction was pressor, the coronary vessels were constricted.

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All abbreviations of periodicals in the above bibliography are letter-by-letter transliterations of the abbreviations as given in the original Russian journal. *Some or all of this periodical literature may well be available in English translation.* A complete list of the cover-to-cover English translations appears at the back of the first issue of this year.
