INFLUENCE OF CARDIAC NERVES ON CORONARY VASCULAR TONE

G. N. Aronova and I. N. Kiryushina

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Experiments on anesthetized dogs have shown that stimulation of the stellate ganglion and ansa subclavia causes an increase in coronary perfusion pressure when a constant volume of blood is delivered to these vessels. Stimulation of the peripheral end of the vagus nerve during coronary perfusion with a constant volume of blood lowers the perfusion pressure.

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Experiments on the heart-lung preparation have demonstrated the vasodilator action of the sympathetic nerves [7, 10]. These results were confirmed in experiments in which the delivery of blood to the coronary vessels was kept constant [2, 13]. During stimulation of the sympathetic nerves the increase in arterial pressure is accompanied by an increase in coronary blood flow [12, 15, 16]. However, a different opinion has been expressed on the action of sympathetic nerves: some authors regard them as vasoconstrictor [9, 17]. Biphasic changes in the coronary blood flow have been observed in some investigations during stimulation of the sympathetic nerve: an initial decrease followed by an increase [4, 6, 8, 11, 19].

No unanimity exists concerning the action of the vagus nerve on the coronary circulation. The decrease in blood flow in the coronary artery or decrease in outflow from the coronary sinus during stimulation of the vagus nerve is associated with a decrease in the inflow into the coronary arteries, so that it is only by experiments in which the inflow of blood is kept constant that reliable evidence can be obtained for solving the problem of the effect of the vagus nerve on coronary vascular tone. The results of such experiments have demonstrated an increase in coronary blood flow during vagal stimulation [3, 4, 14, 18].

The object of the present investigation was to study the effect of stimulation of the sympathetic nerves on the coronary blood flow and the effect of stimulation of sympathetic and vagus nerves on the tone of the coronary vessels with the inflow of blood kept constant.

EXPERIMENTAL METHOD

Experiments were carried out on dogs weighing 13-20 kg anesthetized with morphine and urethane, by two methods: by recording the volume velocity of the coronary blood flow by a thermoelectric method [1] and by resistography [5]. After thoracotomy in the 4th left intercostal space the circumflex branch of the left coronary artery was dissected and a thermoelectrode fixed to it. In the experiments using resistography, this artery was perfused through a cannula with a constant volume of blood supplied from the femoral artery. Changes in perfusion pressure and systemic arterial pressure were recorded. Stimulation of the peripheral end of the vagus nerve in the neck and of the sympathetic nerve (of the stellate ganglion and ansa subclavia) was carried out using buried bipolar electrodes and a type SIF-3 stimulator.

EXPERIMENTAL RESULTS

During stimulation of the stellate ganglion or ansa subclavia, as a rule the arterial pressure and the perfusion pressure in the coronary artery were increased.

Changes in the coronary perfusion pressure during stimulation of the left stellate ganglion are shown in Fig. 1, a and during stimulation of the ansa subclavia in Fig. 1, b. An increase in tone of the coronary vessels was observed even when stimulation evoked a depressor response of the blood pressure (Fig. 1, c). Division of the ansa subclavia led to a small decrease in perfusion pressure, indicating that the nervous

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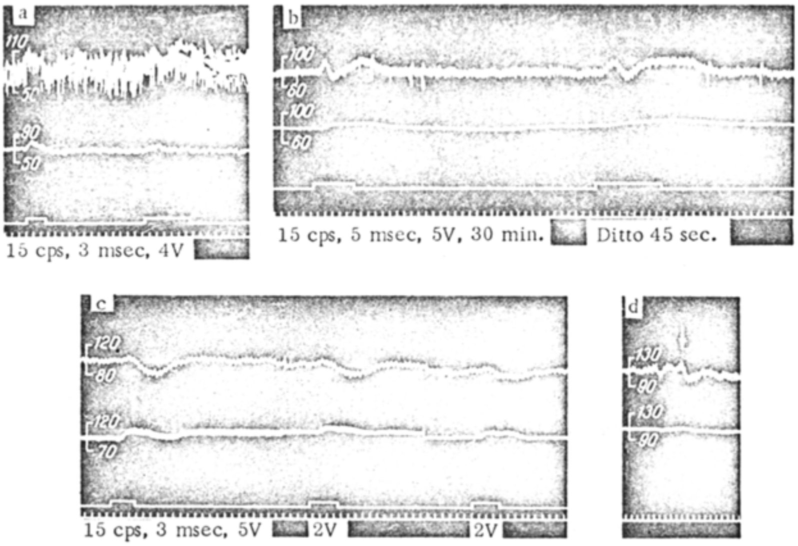

Fig. 1. Increase of perfusion pressure in coronary artery during stimulation of cardiac sympathetic nerves and decrease in pressure after division of ansa subclavia. a) stimulation of stellate ganglion; b,c) of ansa subclavia; d) division of ansa subclavia. From top to bottom: systemic blood pressure, perfusion pressure in coronary artery, marker of stimulation, time marker (5 sec).

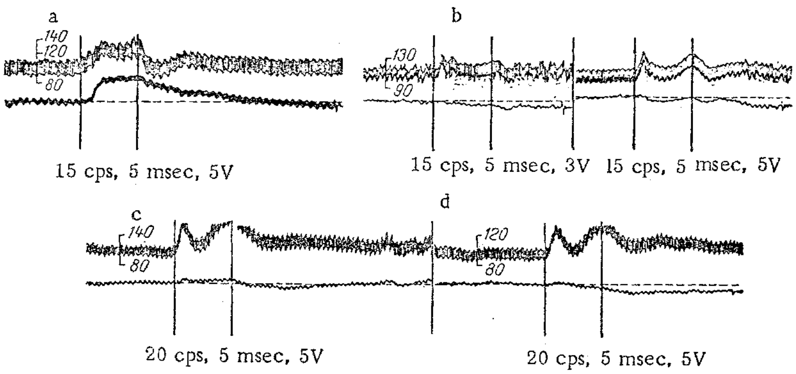

Fig. 2. Changes in coronary blood flow during stimulation of cardiac sympathetic nerves. a) stimulation of stellate ganglion; b) stimulation of stellate ganglion after division of sympathetic chain; c) stimulation of ansa subclavia before division; d) after division of sympathetic chain. From top to bottom: systemic blood pressure, volume velocity of coronary blood flow. Vertical lines represent time of stimulation (30 sec).

system has a tonic influence on the coronary vessels (Fig. 1, d). Experiments in which the coronary blood flow was recorded by the thermoelectric method showed an increase in coronary blood flow during stimulation of the sympathetic nerves, due presumably to elevation of the arterial pressure and a resulting increase in the inflow of blood into the coronary vessels (Fig. 2, a). However, in some experiments at certain stimulation parameters, a decrease in coronary blood flow was recorded against the background of an elevated arterial pressure, indicating constriction of the coronary vessels under these conditions. This phenomenon was seen more clearly after division of the sympathetic chain below the stimulated stellate ganglion. As Fig. 2, b shows, stimulation of the stellate ganglion under these conditions reduced the coronary blood flow. The response to stimulation of the ansa subclavia before division of the sympathetic chain is shown in Fig. 2, c, and after division in Fig. 2, d, when the same pattern was observed.

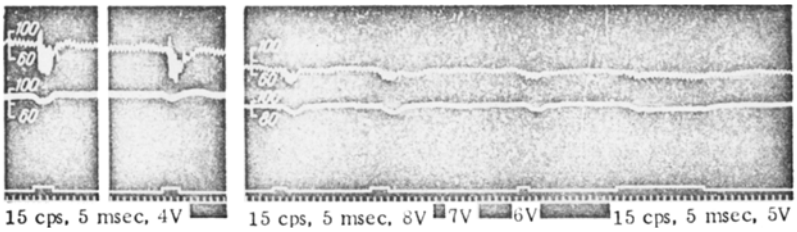

Fig. 3. Decrease in perfusion pressure in coronary artery during stimulation of cardiac branch of vagus nerve. Legend as in Fig. 1.

Stimulation of the peripheral end of the vagus nerve with a constant delivery of blood lowered the perfusion pressure in the coronary vessels. As Fig. 3 shows, this was observed during both brief (10-15 sec) and more prolonged (1 min) stimulation of the nerve. These results confirm the observations of Heidenreich and Schmidt [14] and E. B. Novikova [4], who found an increase in the coronary blood flow during stimulation of the vagus nerve when the perfusion pressure was maintained constant.

On the basis of investigations undertaken in recent years by more refined methods, the view expressed in the textbooks that the sympathetic and vagus nerves have opposite influences on the cardiac vessels compare with those on other organs must evidently be reexamined. However, despite the fact that vasoconstrictor impulses apparently do reach the coronary vessels along the sympathetic nerves, the blood supply to the heart is not necessarily diminished by stimulation of the sympathetic nervous system, but may even be increased. This takes place because the constrictor effects of the nerves are quickly masked by powerful vasodilator factors connected with the increased level of metabolism in the myocardium and also by an increase in the inflow of blood into the coronary vessels resulting from the raised level of the systemic arterial pressure.

The magnitude of the coronary blood flow during stimulation of the sympathetic nerves is determined by the relationship between these factors acting in opposite directions on coronary vascular tone.

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