RESPONSES OF THE CAT FEMORAL ARTERY TO AN INCREASE IN BLOOD FLOW RATE

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In 1933 Schretzenmayr [1] first found dilatation of the femoral artery during contraction of the leg muscles in cats. Further investigations showed that dilatation of the femoral artery arises not only during working hyperemia of the leg muscles, but also in postocclusion hyperemia [8, 9], in response to injection of vasodilators into the arterial system distally to the femoral artery [2-4], and during an increase in the blood flow in the femoral artery produced by means of an arteriovenous shunt [4-7]. The cause of dilatation of the trunk arteries under these circumstances for a long time was a matter for debate. Dilatation of the femoral artery under conditions when it was disconnected from the peripheral vascular system [4-7] undoubtedly indicates the local origin of this reaction. However, it has been shown only recently [10] that dilatation of the artery of the gracilis muscle in dogs arises in response to an increase in the blood flow along that artery and is not a response to a fall of pressure in the vessel.

The benefit of a dilator reaction of the trunk arteries to an increase in the rate of flow of blood among them will be evident. During working hyperemia of the skeletal muscles in cats the blood flow may be 5 or 6 times greater than at rest. Assuming that the fall in pressure in all the large arteries supplying blood to any muscle or group of muscles is 15 mm Hg at rest [12], during working hyperemia it may reach 90 mm Hg. The need for dilatation of the extra- and intramuscular arteries in response to an increase in the blood flow rate along them will be evident from a simple consideration of these figures.

The object of this investigation was to study how the degree of dilatation of the femoral artery in cats depends on the blood flow in it and to examine the dynamics of the dilator reaction of this artery.

EXPERIMENTAL METHOD

Experiments were carried out on 14 cats weighing from 2.3 to 4.8 kg, anesthetized with urethane and chloralose (0.6 and 0.04 g/kg, respectively). To prevent disturbances of respiration a tube was inserted into the trachea; the right

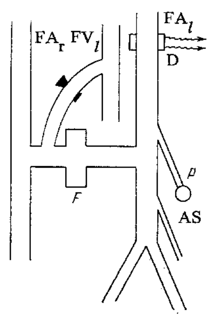

Fig. 1. Diagram of experimental method. FA_l, FA_r) Left and right femoral arteries, respectively; FV_l) left femoral vein; AS) a. saphena; D) diameter transducer; P) electromanometer; F) flow detector of electromagnetic flowmeter.

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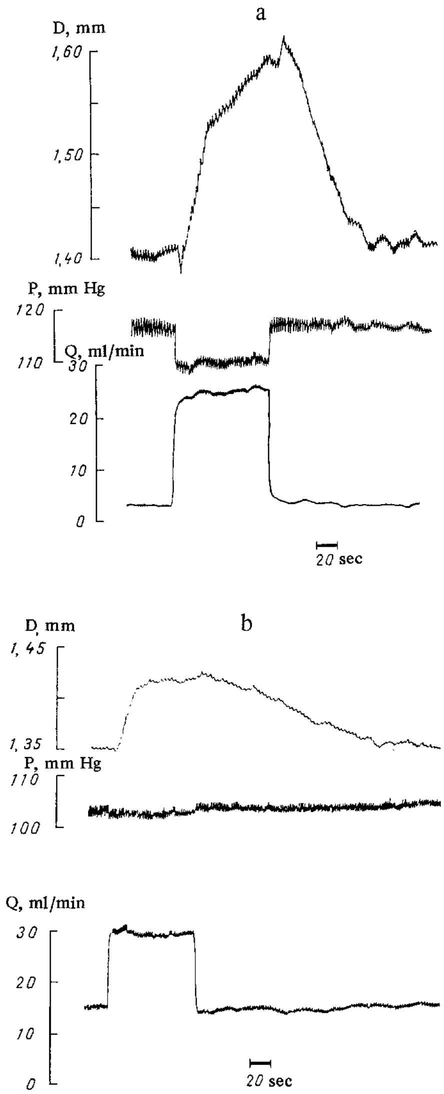

Fig. 2. Dilator response of femoral artery to sixfold (a) and twofold (b) increase in blood flow rate through it. D) Diameter of artery; P) pressure; Q) blood flow.

common carotid artery was connected to a mercury manometer to monitor the arterial pressure. The left femoral artery was ligated before the origin of a. saphena, and after injection of heparin (1000 i.u./kg), it was connected by rubber tubes to the right femoral artery and left femoral vein (Fig. 1). A cannula connected to an electromanometer was introduced into a small muscular branch of the femoral artery. The blood flow was measured by means of the RKE-1 electromagnetic flowmeter with D2M trunk flow detector (diameter 2 mm). The external diameter of the femoral artery was measured by means of a contact capacitive displacement transducer [11]. A segment of the vessel 5-6 mm long was isolated from the tissues in the middle part of the femoral artery and placed on the support of the transducer. A screw clip was applied to the tube connecting the femoral artery to the femoral vein, so that by opening the clip the blood flow in the left femoral artery could be increased the desired number of times. Signals from the electromanometer, flowmeter, and diameter transducer were recorded on two two-channel KSP-4 potentiometers.

EXPERIMENTAL RESULTS

The results of all experiments were qualitatively similar. Characteristic recordings of the dilator reaction of the femoral artery to a fourfold (Fig. 2a) and a 1.5-fold (Fig. 2b) increase in the blood flow through it are shown in Fig. 2. Immediately after the increase in blood flow the diameter of the artery decreased a little, due to the fall in pressure at the point where the diameter was measured. A short time after the beginning of the increase in blood flow (latent period) the artery began to dilate; the increase in diameter as a rule was biphasic in character. The first phase was distinguished by a rapid (3-10 μ/sec) increase in diameter and it lasted 10-25 sec. The rate of increase of diameter in the second phase was

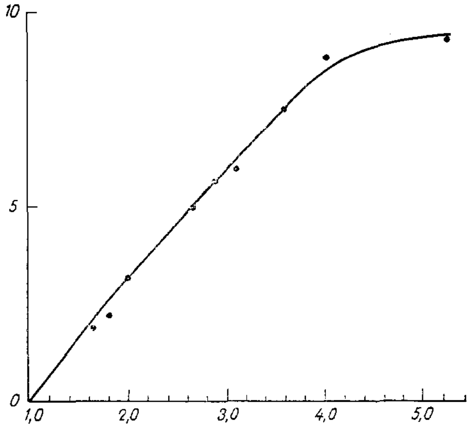

Fig. 3. Increase in diameter of femoral artery (in % of initial value) as a function of degree of increase in blood flow. Abscissa, degree of increase in blood flow; ordinate, degree of dilatation of artery.

significantly less (under 2μ/sec), and with moderate increases in the blood flow (1.5-2 times higher than the background level) the increase in diameter in the second phase did not take place. The rate of increase of diameter during the first phase correlated well with the relative increase in blood flow: With a 5-6-fold increase in blood flow it reached 10 μ/sec, whereas with a twofold increase in blood flow it rarely exceeded 6-6.5 μ/sec. The latent period of the reaction was usually 7-12 sec, and only in response to very small increases in blood flow (not more than twofold) was it appreciably increased (up to 20-25 sec). At the end of the period of increased blood flow the diameter increased a little because of restoration of the initial pressure, after which the original dimensions of the artery began to be restored either at once or after a short delay. Recovery of the original diameter was linear for 2-5 min. No definite correlation could be found between the rate of recovery and the intensity of stimulation (the degree of increase in blood flow).

Dependence of the degree of dilatation of the artery on the degree of increase in blood flow is illustrated in Fig. 3. With a fivefold increase in the blood flow rate through the artery its external diameter increased by 10%. This corresponds to an increase of 14% in the internal diameter and, consequently, to a decrease in the hydraulic resistance of the artery by about 1.7 times.

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