REACTION OF SMOOTH MUSCLES OF SUBCUTANEOUS BLOOD VESSELS TO pH CHANGES

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Experiments on the marginal vein of the isolated rabbit's ear showed that with a change in pH of the perfusion fluid toward the alkaline side the spike activity of the smooth-muscle cells of the blood vessels is increased, and as the pH returns to normal the activity regains its initial level.

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Very little information is given in the literature on reactions of the smooth muscles of blood vessels to changes in the pH of the solution bathing them. Barton and Hilton [2] consider that an increase in acidity resulting from excess of CO_2 in the blood causes dilatation of the peripheral vessels, while a change to alkalinity causes their constriction. Johansson and Bohr [4] indirectly mention the importance of pH as a factor modifying the activity of muscles of blood vessels.

In normal blood, despite its relatively high homeostasis, fluctuations in the acid-base balance occur. The question of the relationship between the activity of vascular smooth muscles and the level of the hydrogen ion concentration is therefore of definite importance.

The study of this relationship in the subcutaneous blood vessels, which play an important role in thermoregulation, was the object of the present investigation.

EXPERIMENTAL METHOD

The test object was the marginal vein of the isolated rabbit's ear (Kravkov's preparation).

To record the spike activity of the smooth-muscle cells of the blood vessels, the potentials were recorded extracellularly by means of metallic microelectrodes insulated with polystyrene. The electrodes were sharpened electrolytically and the diameter of the tip was 2-5 μ. Potentials were fed into a cathode follower and UBP1-01 amplifier and recorded photographically.

Since extracellular recording was used, the activity of the muscles was judged from spikes generated from several neighboring cells in the immediate proximity of the electrode tip.

The vessel was perfused with Krebs–Henseline or Ringer–Locke solution at a temperature of 25-30° and a pressure of 10 mm Hg; the pH of the original solution was 7.2. To test the responses of the vessel the pH of the solution was adjusted for 8.0 by addition of NaOH. The perfusion pressure was unaltered as the solutions were changed. The change in vascular tone was judged from the number of drops of perfusion fluid escaping from the outlet cannula. The falling drops were recorded on the second channel of the photographic recorder by means of a piezoelectric detector.

EXPERIMENTAL RESULTS

Altogether 18 experiments were carried out. The spike activity was recorded 2-3 min after insertion of the microelectrode as the vessel was perfused with solution of pH 7.2. The mean number of spikes was 2.6 ± 0.3/sec. The vessel was then perfused with a solution of pH 8.0. After 4-7 sec (the latent period) the frequency of the spikes increased, to reach a maximum 2-3 sec later (mean 5.9 ± 0.5/sec) at which level it remained throughout the period of perfusion (Fig. 1).

On subsequently perfusing the vessel with solution of pH 7.2, the frequency of the spikes generated by the smooth muscles decreased, the latent period in this case being shorter (3-5 sec), and the time required for spike activity to reach a constant level increased to 6-14 sec.

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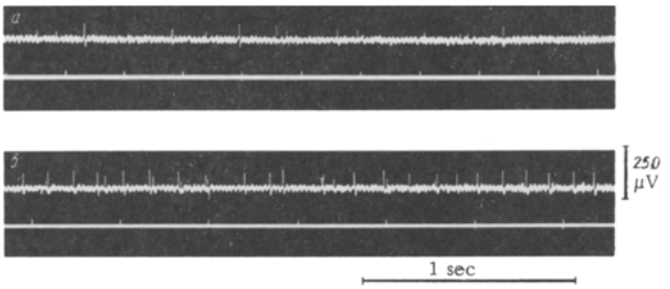

Fig. 1. Spike activity of smooth-muscle cells of blood vessels during perfusion with solution of pH 7.2 (a) and pH 8.0 (b). The upper curve on each trace represents spikes, the lower curve drops of escaping fluid.

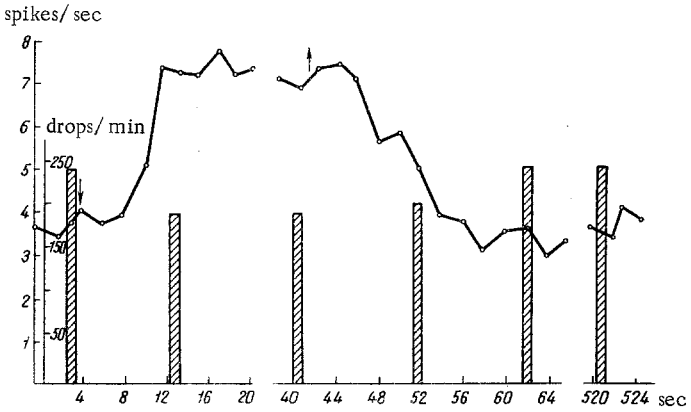

Fig. 2. Changes in spike activity of smooth muscles of blood vessels (curve) and in number of outflowing drops (columns) as a function of pH of the perfusion solution. Arrow pointing downward indicates beginning of perfusion with solution of pH 8.0; Arrow pointing upward—ditto, pH 7.2.

Despite the considerable difference in the increase in spike activity with a change to alkalinity in different experiments, all the results followed the same patterns reflected in Fig. 2.

In some experiments periodic fluctuations of spike activity unconnected with stimulation of the vessel were observed. The lower the level of spike activity the more pronounced these fluctuations were, and they were evidently due to spontaneous changes in vascular tone of myogenic character [3]. Similar fluctuations were observed by Attardi [1].

The amplitude of the spikes differed from one experiment to another (from 25 to 200 μV), but was unaffected by the change in pH.

The observations showed that a change in pH of the perfusion solution from 7.2 to 8.0 causes a considerable increase in electrical activity of the smooth-muscle cells of blood vessels. The subsequent decrease in the volume of fluid flowing through the vessel per unit time indicates a reduction in its lumen caused by contraction of the circular muscles. When the pH returns to the physiological normal level, spike activity again diminishes and the increasing number of drops indicates a decrease in tone of the vascular muscles.

LITERATURE CITED

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