EFFECT OF LOCAL ACTION OF HEAT AND COLD ON ARTERIAL AND VENOUS PRESSURES, LYMPH FLOW AND RESPIRATION

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It is known that if the whole body is heated or cooled by a large amount, changes in the cardiovascular system, respiration, lymph flow, and lymph formation occur. Thus, V. V. Parin, A. P. Polosukhin, and V. N. Chernigovskii [6] and A. M. Blinova [2] have shown that thermal stimuli cause an increase in the output of the heart. G. A. Malov has shown that warmth applied locally will raise venous tone, and that cold lowers it. A. G. Zabolotskii [3] in studying variations of venous pressure in healthy and sick human subjects observed that venous pressure is raised by hot baths, and lowered by cold. M. I. Kokhanina [4], working on adult dogs, showed that both heat and cold applied locally increase lymph flow; in her opinion, lymph flow changes occur reflexly in response to stimulation of the cutaneous receptors. I. A. Bermzhanova [1] obtained similar results in puppies. Cold or hot stimuli applied to the outer ear or hind feet increased lymph flow in the first few days after birth.

The object of the present investigation was to determine how lymph flow is related to arterial and venous pressure, and respiration, as affected by local thermal stimuli.

METHOD

Forty-one acute experiments were carried out on adult dogs under morphine-pentothal anesthesia. For the heat stimulus, water at temperatures between 40° and 50° was used, while the cold stimulus was given by snow, or tap water at temperatures from +2 to 15°; it was applied in the region of the groin, belly, or back. The stimulation was continued for 1-3 minutes. One ml per kg of a 1% solution of inulin was given as an anticoagulant. The method for recording changes in arterial and venous pressure, lymph flow, and respiration have been described in detail in our previous article [3].

RESULTS

Application of heat to the groin, belly, and back gave the same results. In 17 of the 26 experiments, there was no change in arterial pressure, in 6 it was raised, and in 3 it fell. The venous pressure in the femoral vein rose, except in 2 experiments when it remained unchanged; in most experiments there was also an increase of venous pressure in the portal vein, but no change in the jugular vein. Respiration remained constant. Lymph flow varied as follows: in 21 experiments it was increased, in 4 it remained unchanged, and in 1 it was reduced.

The results of the experiment on February 15, 1952 are presented as typical of those obtained. Local heating of the belly to 50° for 2 minutes 15 seconds had no effect on arterial pressure or on that in the jugular vein; pressure in the femoral vein rose from 33 to 48 mm of water, and after 50 seconds' stimulation, to 50 mm. There was a marked increase in the lymph flow (Fig. 1).

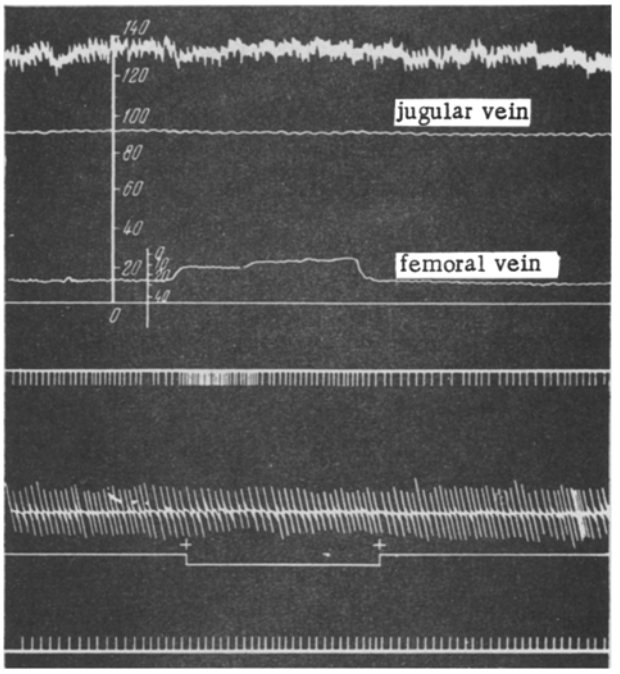

Fig. 1. Change in the reflexes in a 7 kg dog in an experiment performed on February 15, 1952 in which the belly was heated to +50° for 2 minutes 15 seconds. Curves, from above downwards: arterial pressure, two curves of venous pressure, zero line for arterial pressure, trace showing drops of lymph, respiration curve, stimulus marker, time marker (5 seconds).

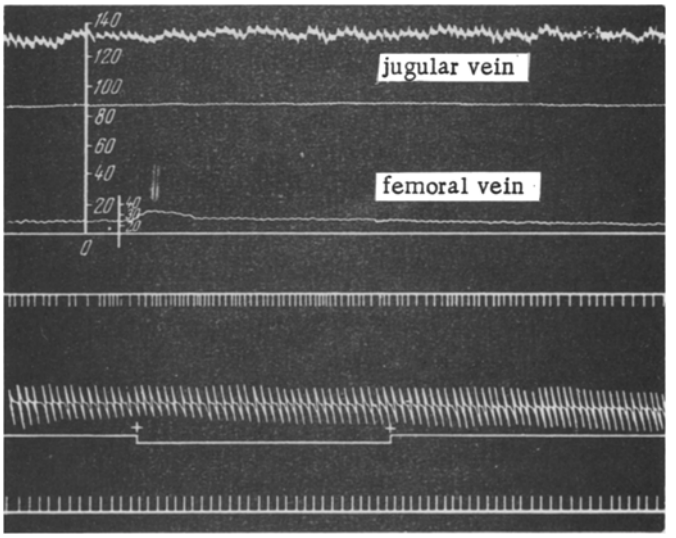

Fig. 2. Change in reflexes in a 10 kg male dog in an experiment performed on March 15, 1952 in which the inguinal region was cooled to -2° for 2 minutes. Curves as in Fig. 1.

With cold stimulation of the same regions, in 12 experiments there was no change in arterial pressure, in 1 it was raised, and in 2 it was reduced. The venous pressure changed in different ways: in the femoral vein, it was raised in 10 experiments, while in 3 there was no change; in the portal vein, it was raised in 1 experiment and unchanged in 3. In 10 of the experiments there was an increase in lymph flow, and in 5 no change occurred. Respiration did not vary.

As an illustration, the kymogram obtained in an experiment on March 15, 1952 may be considered (Fig. 2). The application of a cold compress to the inguinal region caused a marked increase in lymph flow in the theoracic lymph duct; it rose from 20 to 50 drops per 2 minutes, while the pressure in the femoral vein rose from 25 to 30 mm of water. There was no change in arterial pressure, pressure in the jugular vein, or respiration.

Reports have been published that lymph flow and venous pressure changes depend on the pumping action produced by the thorax and by muscular tension. In order to find the effect of these influences on lymph flow and venous pressure, we carried out experiments in which a bilateral pneumothorax was established, and artificial respiration maintained under deep anesthesia. When this was done, the same effects occurred as when normal breathing was maintained, but they were less well shown.

The results of the experiment allow us to conclude that both in experiments with natural breathing and when respiration was maintained artificially, changes in lymph flow and venous pressure in the femoral vein occurring in response to heating the skin of the groin, belly, and back occur reflexly and independently of changes in respiration of muscle tension. However, we do not deny that there is some relationship between lymph flow and various extracardial factors.

SUMMARY

Forty-one acute experiments were conducted on adult dogs. The inguinal region, abdomen, and back were heated to a temperature of 40-50°C or cooled to temperatures between -2° and 15°.

The observations were made while breathing was carried out naturally or by artificial respiration. It was found that local thermal stimulation provoked a reflex change of lymph flow and an increase in the venous pressure of the femoral and portal veins. However, lymph flow and venous pressure may depend to a certain extent upon various extra-cardial factors such as muscular tension, etc.

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*See C. B. Translation.

**In Russian.