PECULIARITIES IN THE REFLEX REACTIONS OF THE THERMORECEPTORS IN FEBRILE PATIENTS

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Many investigators [7, 9, 10, 17] have attributed great significance to cutaneous reception in the thermoregulation of the organism. However, only recent works [2, 5, 6, 7, 11, 12, 13, 15] have shown the functional changes which the cutaneous thermoreceptor system undergoes when it is acted upon by a temperature factor. It has been established that the functional "adjustment" of the thermoreceptors changes in character, depending on whether the temperature stimulus acting on the human organism is local, reflex, or general. In connection with this, it was noted that the functional state of the cutaneous thermoreceptors is specifically related to the functioning of the effector apparatus participating in heat regulation of the organism. On the basis of this, it was postulated that the thermoreceptors do more in the regulation of the heat exchange processes of the organism than just signaling the temperature changes that occur in the surrounding milieu and inside the organism. Their functional adjustment also changes, as manifested by a change in the number of functioning receptor elements. These changes in the adjustment of the thermoreceptors are apparently accomplished throught centrifugal impulsation. This point of view is corroborated by the fact that, in a number of pathological conditions of the central nervous system (in particular, in the case of vascular injuries within the brain), where temperature sensitivity has been preserved, one observes a disturbance in the adjustment of the thermoreceptors [16].

In connection with this, there was definite interest in investigating thermoreceptor function during a disturbance in the constancy of the body temperature, as well as comparing the character of the reflex reactions of the thermoreceptors, sweat glands, and vessels of the skin, under normal conditions and in association with croup pneumonia, accompanied by a febrile reaction.

For these purposes, along with investigating the functioning of the cutaneous thermoreceptor system we determined the skin temperature of the corresponding portion of the body (as an index of the vascular reaction) and the sweat secretion. The body temperature was determined in the axillary (right and left) and inguinal (right and left) regions, as well as rectally. In addition, observations were made for changes in the heat regulation reflex, according to the method of Shcherbak.

We studied 12 patients with croup pneumonia, ranging from 20 to 65 years of age. This work presents the results obtained from studying patients during the acute febrile period.

EXPERIMENTAL METHOD

After measuring the body temperature in the indicated areas, we determined the functional state of the thermoreceptors and the heat regulation reflex. To study the reflex adjustment of the thermoreceptors, we used the procedure described earlier [6, 7].

First, using a cold thermoesthesiometer, we located 10 cold points on the internal surface of the forearm. Then, following preliminary adaptation (for 10 minutes) to the room temperature, we determined the starting number of functioning cold receptors. Simultaneously, with the aid of an electrothermometer, we determined the skin tempera-

ture of the area under study. Then, on the other hand, we administered a warm bath for 20 min, using a water temperature of 45°. At 2, 10, and 20 min after initiation of the warming, we again determined the number of functioning thermoreceptors and the skin temperature on the arm being studied. After completion of the warm bath, these same indices were determined again at 2, 10, and 20 min. The bath was applied to the hand on the "healthy" side of the body. The investigation was carried out with the hand on the side of the focus of infection.

At the same time, we carried out observations on the heat regulation reflex, according to Shcherbak. For this purpose, the rectal temperature was measured before and immediately after the warm bath was administered to the arm, as well as 15-30 min and 1 hr afterward. A comparison of the data obtained from determining the corresponding indices before application of the arm bath, during the action of the bath, and after it allowed us to appraise the character of the reflex adjustment of the thermoreceptors, the reflex vascular and sweat-secretion reaction, and the heat regulation reflex.

EXPERIMENTAL RESULTS

During the acute febrile period, the patients showed a clearly manifested asymmetry in the body temperature, in various regions. While in healthy people, with normal body temperature, the asymmetry in the axillary regions is equal to 0.1-0.3° [6], in the patients undergoing an acute febrile period it reached 1-1.6°. The body temperature on the side of the focus of infection was always higher than on the "healthy" side.

These temperature asymmetries were also observed in the inguinal regions of these patients. In addition, we noted a significant difference between the body temperature in the axilla and the rectal temperature. Normally, the latter exceeds the axillary temperature by 0.5-0.8°. In the febrile patients, we observed both isothermia (axillary and rectal temperature the same) and thermoinversion (rectal temperature lower than axillary). As an example, patient Ya., with left-sided pneumonia, showed body temperatures of 37.2° in the right axilla, 38.8° in the left axilla, and 37° in the rectum (thermoinversion).

The cutaneous thermoreceptor system, and the systems participating in heat regulation, undergo significant changes in the patients during the acute febrile period. Above all, these changes manifest themselves by a disturbance in the reflex adjustment of the thermoreceptors to temperature stimulation (arm bath with water at a temperature of 45°).

As would follow from Fig. 1, the original functional level of the thermoreceptors in patient N. was equal to 4-5 (out of the 10 points found earlier). This is evidence that at a high body temperature the number of functioning cutaneous cold receptors decreases significantly. During the action of the temperature stimulation, instead of the reflex lowering of the functional level of the receptors, seen in the normal individual, no reflex response of the thermoreceptors whatsoever was noted in the patient (the number of functioning thermoreceptors was the same – 4-5). The same picture was observed after cessation of the warmth stimulus action.

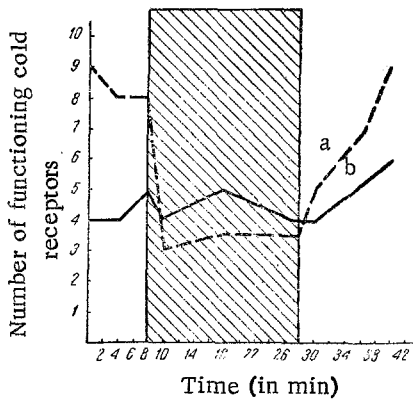

Fig. 1. The effect of temperature stimulation on the reflex adjustment of the skin thermoreceptors under normal conditions (a) and in a febrile patient (b). The period of action of the warm bath is crosshatched.

In certain of the acutely febrile patients we observed instability of the thermoreceptor reaction. It has been established that the vascular reaction of the skin changes along with a disturbance in the functioning of the thermoreceptors. In Fig. 2, it can be seen that in patient N. the original skin temperature on the investigated surface of the forearm was 33.3°, during warm bathing of the other arm it increased to 33.5°, and after cessation of the bath, it did not return to the original level, but continued to increase and reached 34°. Under normal conditions, one observes a significant (up to 0.9-1°) reflex elevation in the skin temperature during the action of a warmth stimulus, and a gradual decrease after its termination. Thus, in this patient we noted an inertia in the vascular reaction.

Sometimes we even observed distortion of the vascular reaction in the patients. Investigation of the heat regulation reflex in the febrile patients showed its pathological inversion. According to the data of a number of authors [1, 9, 10], in essentially healthy individuals, immediately after an arm bath (at 45°) applied for 20 min, the rectal temperature increases by 0.4-0.5°, and after 15-30 min, again arrives at the original level. In the patients with pneumonia,

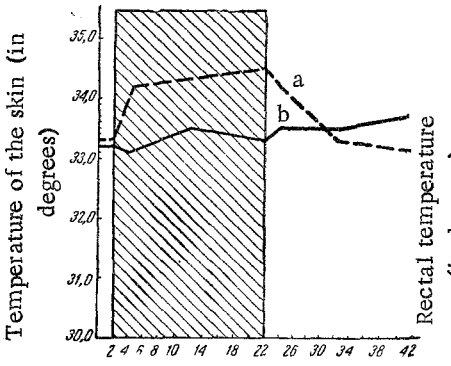

Fig. 2

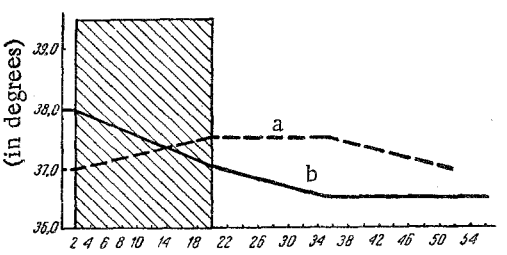

Fig. 3

Fig. 2. The action of a temperature stimulus on the reflex skin change under normal conditions (a) and in the febrile patient (b). Symbols are the same as in Fig. 1.

Fig. 3. Graphic representation of the heat regulation reflex under normal conditions and in febrile patients. Symbols are the same as in Fig. 1.

during the acute febrile period the heat regulation reflex was completely disrupted. This was manifested by the fact that after the arm bath the rectal temperature not only did not rise, but either remained unchanged, or even fell in a number of cases. As an example, we have shown a graphic representation of the heat regulation reflex in patient N-o (Fig. 3).

The facts presented bear evidence that when thermoregulation of the organism is disturbed, as a result of one or another pathological process leading to an elevation in the body temperature, the reflex adjustment of the cutaneous thermoreceptor system, which represents the first link in the organism's whole system of thermoregulation, is altered.

With absence of the centrifugal adjustment of the thermoreceptors in febrile patients, despite maintenance of temperature sensitivity, there is a disturbance in the signaling of the cutaneous thermoreceptors pertaining to temperature shifts that occur. As a result, the normal functional connection of the skin thermoreceptor system with the heat emission apparatus is disrupted. This is demonstrated by the fact that a disturbance in the reflex adjustment of the thermoreceptors is accompanied by a change in the vascular reaction of the skin, as well as in the functioning of the sweat glands. The heat regulation reflex determined by the method of Shcherbak also undergoes pathological alterations.

All this is evidence of a disturbance in the coordination activity of the thermoregulatory mechanisms, seen in patients with pneumonia during the acute febrile period.

SUMMARY

Functional investigations of thermoreceptors in patients with pneumonia showed that in the acute period the reflex regulation of cutaneous thermoreceptors was disrupted while the thermal sensitivity remained unchanged. It is accompanied by alteration of the vascular and perspiration reaction and pathological change of the thermoregulation reflex. The data obtained testifies to disturbed functional correlation between thermoreceptors and effectors which participate in the thermoregulation.

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