DYNAMICS OF CHANGES IN THE CEREBRAL ZONAL AND CORONARY CIRCULATION DURING THE ACTION OF AN EXTREMAL STIMULUS

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Investigations of the dynamics of changes in the cerebral zonal and coronary circulations during the action of an extremal stimulus showed that the resulting development of a neurotic state in the animals is accompanied by marked variability of the circulatory responses amounting in some cases to reversal of the response. The identical character of the responses of the cerebral and coronary blood vessels to the stimuli is a noteworthy feature.

Investigations [2-4, 6, 8] have shown that stressor stimulation induces changes in the character of responses of the coronary vessels.

The similarity between responses of the cerebral and coronary vessels to various stimuli coupled with the high frequency of vascular lesions of the brain directs attention to the dynamics of changes in the cerebral and coronary circulations under the influence of extremal stimuli and justifies a comparison of the character of the changes in the cerebral and coronary blood flow in response to these stimuli.

EXPERIMENTAL METHOD

The dynamics of changes in the cerebral (five dogs) and coronary (three dogs) blood flow was investigated by a thermoelectric method under chronic experimental conditions.

The blood supply of the brain was recorded in the motor cortex in areas designated R_{chs_1} and R_{chs_2} in the atlas of Adrianov and Mering [1]. To determine the coronary blood flow, thermoelectric monitors were placed on the circumflex branch of the left coronary artery. The methods of implanting the electrodes were described previously [5, 9].

The extremal stimulus consisted of a combination of giving food and nociceptive stimulation of Kryazhev's method [7]. The essence of this method is that as soon as the animal touches the food an electric circuit is closed and the dog receives a nociceptive stimulus.

Observations on the animals continued for as long as the electrodes lasted, and on the average this time varied from 3 to 4 weeks.

EXPERIMENTAL RESULTS

In experiments in which feeding the animals was not accompanied by pain, an increase in both cerebral and coronary blood flow was observed while the arterial pressure was very slightly increased or unchanged (Figs. 1a and 2a).

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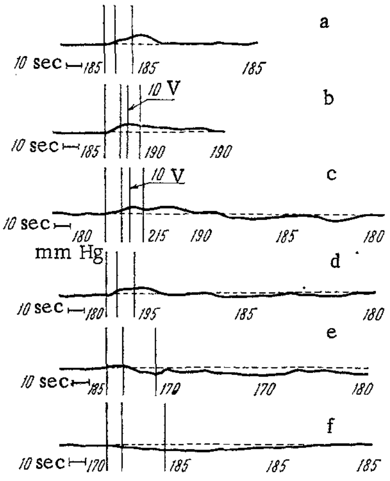

Fig. 1

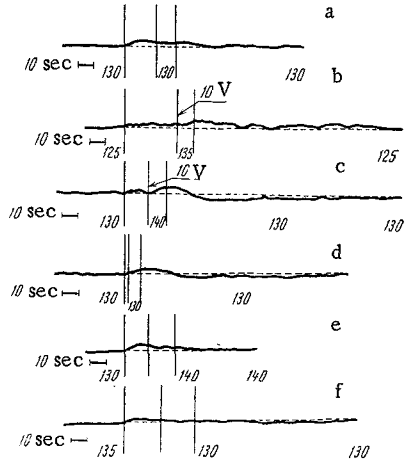

Fig. 2

Fig. 1. Character of changes in cerebral zonal blood flow during combination of defensive and conditioned food reflexes in chronic experiments (explanation in text). On all curves first vertical line denotes moment when laboratory attendant stood up and walked to the food store; second line denotes food placed in front of animal (in curves b and c the additional vertical line with the 10-V mark denotes time of nociceptive stimulation); third vertical line denotes food taken away. Numbers show arterial pressure (in mm Hg).

Fig. 2. Character of changes in coronary blood flow during combination of defensive and unconditioned food reflexes in chronic experiments (explanation in text). Legend as in Fig. 1.

During the first combinations of giving food and nociceptive stimulation, the cerebral and coronary blood flows also were increased. The magnitude of these changes was the resultant of the magnitude of the changes evoked by food and nociceptive stimulation; the time taken for the blood flow to return to its initial level was almost doubled (Figs. 1b and 2b).

Further applications of these combined stimuli led to marked changes in the animals' behavior. Although the dogs ran eagerly into the experimental room, it was difficult to get them into the apparatus. Whereas previously they had stood quietly on the bench, the animals now were on their guard at the slightest movement in the experimental room, they howled, moved restlessly, or alternatively, they fell asleep and hung on their straps. All these changes in behavioral responses are characteristic of the development of neurosis [10]. The changes observed in the animals' behavior were also accompanied by changes in the responses of the blood flow in the myocardium and motor cortex.

After several repetitions (7-10) of the combinations of giving food and nociceptive stimulation, the responses of the cerebral and coronary vessels became biphasic in character, i.e., an increase in blood flow (phase I) was followed by its decrease below the original level (phase II). These changes in the blood flow took place against the background of a raised arterial pressure, and it was 3-4 min before the normal blood flow was restored (Figs. 1c and 2c).

In the next experiments the dogs no longer touched the food, but, as soon as it was placed in front of them, they developed changes in blood flow characteristic of those to the combination of food and nociceptive stimulation (Figs. 1d and 2d).

Since the dogs refused to take food, the course of the experiments had to be somewhat modified. The nociceptive stimulation was applied when the food was in front of the animal. After several such repetitions, the decrease in blood flow took place at the moment of offering the food (Figs. 1e and 2e). Whereas at the beginning of the experiment the dogs became animated whenever the laboratory attendant went to the food store, toward the end of the experiments they stood on their guard at any movement in the experimental room. The cerebral blood flow was actually reduced when the laboratory attendant, who had taken part in the experiments for a long time, moved to where the food was normally kept (Figs. 1f and 2f).

The use of a powerful stressor such as a combination of food and nociceptive stimulation thus led to the development of a neurotic state manifested by changes not only in behavioral responses, but also in the character of the responses of the cerebral and coronary blood flow. The decisive factor was not so much the intensity of the nociceptive stimulation as the constancy of the experimental situation. Pain by itself, incidentally, led to a much less marked disturbance of behavior than pain combined with emotional agitation.

Comparison of the changes in the cerebral and coronary circulation evoked by powerful stressor emphasizes the identity of the responses of the cerebral and coronary vessels. This suggests that these vessels share common mechanisms of regulation and also that negative emotions play an important role in the etiology of diseases of the coronary and cerebral circulation.

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