

CAROTID SINUS REFLEXES WITH FOREIGN BLOOD STIMULATION OF THE SPLEEN INTEROCEPTORS

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The pathogenesis of circulatory and respiratory disturbances due to blood transfusion shock is not yet clear.

According to the data of A. N. Gordienko [1], the carotid sinus circulatory reflexes are profoundly changed in dogs due to blood transfusion shock caused by an intravenous infusion of heterogeneous blood. The indirect action of foreign blood on the receptors of an isolated carotid sinus results a similar picture [2]. In the opinion of the authors cited, this phenomenon indicates that the function of the peripheral neuroreceptive apparatus is profoundly disturbed during shock, and these disturbances perhaps play a principal role in the pathogenesis of hemodynamic changes.

Accepting the premise of contemporary physiologists that the afferent impulsion emanating from the receptors of the cardiovascular system plays an important part in the maintenance of the tonicity and excitability of the centers regulating circulation and regulation, we decided to investigate the mechanism of the phenomenon mentioned.

EXPERIMENTAL METHODS

The experiments were done on dogs, in which the spleen had been humorally isolated according to V. N. Chernigovsky [4] under ether or hexenal* anesthesia, after the anesthesia had passed.

0.2 ml of a solution of lobeline hydrochloride or acetylcholine (1:25,000), or of a 0.2% solution of sodium sulfide, was introduced into the central part of the superior thyroid artery in order to stimulate the chemoreceptors of the carotid zone.

The intensity of the carotid sinus circulatory and respiratory reflexes was determined from the rise in arterial pressure and the change in the rhythm and depth of the respiratory movements, which were recorded in the course of the experiment.

The reflexes were examined at the following intervals: before laparotomy and humoral isolation of the spleen, after splenic isolation, on a background of splenic perfusion with citrated rabbit's blood and 15, 30 and 45 minutes after perfusion. Perfusion of the humorally isolated spleen with the citrated rabbits' blood lasted 5 or 10 minutes.

EXPERIMENTAL RESULTS AND EVALUATION OF RESULTS

It has been established that the operation of opening the celiac cavity in order to humorally isolate the spleen affects the course of the carotid reflexes. The carotid reflexes caused by lobeline were the most changeable, and the reflexes caused by sodium sulfide were the most resistant.

As a rule, the reflexes decreased in magnitude, and the presence of a depressor phase, replacing the pressor beginning of the reaction, was frequently observed.

* Russian trade name.

Only in 3 out of 19 cases did the carotid reflex to lobeline increase, and in four cases, after the operation, the reflexes to sodium sulfide increased.

Opening the cellac cavity and manipulating its organs evidently changes the functional condition of the nervous system. Consequently, reflexes caused by the stimulation of carotid sinus chemoreceptors are changed.

The carotid reflexes did not diminish during the splenic perfusion with foreign blood, which led to a pressor-depressor reaction, but, conversely, showed a definite tendency to increase (Fig. 1). This tendency was strongest in the reflexes caused by lobeline and sodium sulfide. In the first case, the hemodynamic component of the reaction was most intensified, in the second, the respiratory component (Fig. 2 and 3).

A slight decrease in the reflex reaction to acetylcholine occurred in 12 out of 19 experiments; a biphasic reaction was observed in 3 experiments, and an inverted circulatory reaction even occurred in 2 experiments, expressed by arterial pressure depression. The respiratory component of the carotid reflex, however, was almost unchanged.

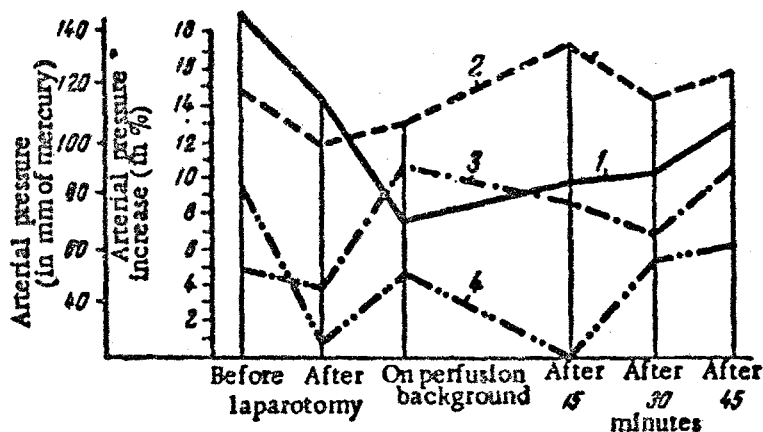


Fig. 1. Changes in carotid circulatory reflexes with foreign blood perfusion of the spleen.

1) arterial pressure; 2) reflexes to lobeline; 3) reflexes to sodium sulfide; 4) reflexes to acetylcholine.

In 3 experiments in which the carotid sinus reflex to acetylcholine was pronounced from the very beginning, foreign blood stimulation of the spleen interoceptors caused it to diminish.

The presence of an expressed reaction to lobeline during the hypotonia caused by the pathologic stimulation of the spleen interoceptors with foreign blood indicated the great stability of this reaction and the possibility that it has a compensatory-defense significance. The compensatory-defense character of this reaction is confirmed by the fact that, in the experiments in which the carotid reflexes to lobeline increased 15 and 30 minutes after the heterogeneous blood irrigation, the arterial pressure, which had dropped due to this irrigation, was completely restored after even shorter intervals. When the reflex reaction to lobeline decreased due to excessive stimulation of the spleen receptors with the rabbit's blood, restoration of arterial pressure proceeded much more slowly. Analyzing the dynamics of the carotid sinus reflexes to sodium sulfide disclosed an analogous picture.

We could not establish a strict relation between the arterial pressure changes in the dogs in which the spleen receptors were stimulated with heterogeneous blood and the character or intensity of the carotid sinus reflexes caused by acetylcholine. Moreover, in spite of the presence of inverted carotid sinus reflexes to acetylcholine, in 2 experiments, one could observe a steady restoration of arterial pressure after foreign blood perfusion of the spleen. This makes it possible to propose that the nervous mechanisms producing the reaction from the carotid chemoreceptors to acetylcholine do not play an essential part in the restoration of arterial pressure.

Analyzing the results obtained from studying the reflex reactions of the reflexogenic carotid sinus zone to various chemical stimuli permits one important point to be established.

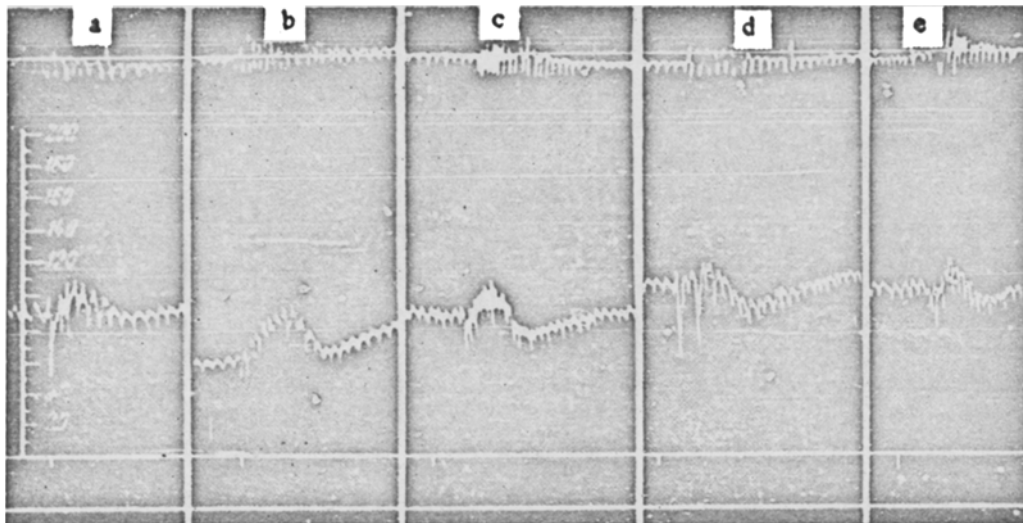


Fig. 2. Reaction from receptors of carotid sinus zone to lobeline during the action of foreign blood on the spleen interoceptors.
a) carotid sinus reflex on circulation and respiration before foreign blood perfusion of spleen (after spleen isolation); b) the same on a background of foreign blood perfusion; c,d,e) the same 15,30 and 45 minutes after perfusion. The curves from top to bottom signify: respiration, arterial pressure, zero line and indication of stimulation, indication of time (in 1 second marks).

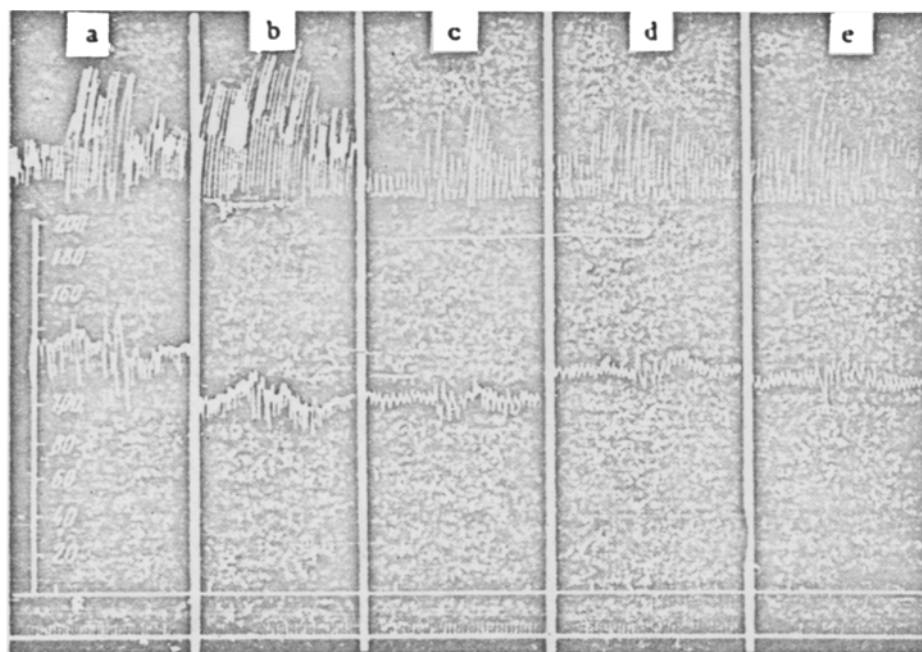


Fig. 3. Reaction from the receptors of the carotid sinus zone to sodium sulfide with the action of foreign blood on the spleen interoceptors.

Stimulating the splenic receptor field with heterogeneous blood under conditions of splenic isolation from general circulation can change the condition of the reflexes arising from another receptor field, that of the carotid reflexogenic zone, far from the direct action of the blood.

We proposed that the mechanism of such a change is reflex and is connected with changes in the nervous processes in the carotid sinus reflex centers. If our proposition is valid, then, no matter to which reflexogenic zone the action of the blood is primarily directed, the effect should be the same.

In order to prove this proposition, we conducted supplementary experiments. The receptors of an isolated carotid sinus were subjected to the action of heterogeneous blood, and the reflex reactions from the intestinal interoceptors to the introduction of the same chemical stimuli, with the exception of sodium sulfide, were examined.

The carotid sinus was isolated from general circulation by the method described by A. N. Gordienko and V. I. Volkotrub [2], and the section of the small intestine was isolated according to V. N. Chernigovsky's method [4].

Solutions of the chemical substances, in the same concentrations as before, were introduced into a perfusion current irrigating the isolated intestine, in amounts of 1.2 ml.

The reflex reactions to these stimuli were examined before carotid sinus perfusion with foreign blood, on a perfusion background and 15 and 30 minutes after the perfusion.

Two particularly interesting facts resulted from the analysis of the results obtained in these experiments: during carotid sinus perfusion with heterogeneous blood, the reflex reactions from the intestinal receptors to the chemical stimuli greatly diminished; during the period in which these reactions were restored to their original magnitude, a phase of increase occurred at the time when foreign blood perfusion of the carotid zone was halted.

One can propose that the heterogeneous blood stimulation of the carotid zone chemoreceptors causes a condition similar to parabiosis in the central nervous system. When this stimulation ceased, the functional condition of the central nervous system (or more exactly, the central links in the arc of the studied interoceptive reflexes) is restored.

The phase of increased reflex reactions present during the restoration period can be considered as a manifestation of the paradoxical stage of parabiosis in the course of slow involution.

The experiments conducted, then, confirm the proposition that change is possible in the reflex reactions to chemical stimuli from receptor fields far removed from the place of the pathogenic stimulus's direct action.

The change in the magnitude of the reflexes originating from receptor zones not in direct contact with the pathologic stimulus possibly have either a defense-adaptive or a pathologic significance to the body, depending on the conditions of development.

SUMMARY

It was established in experiments on dogs that when isolated vascular zones (carotid sinus and spleen) were perfused with heterogeneous blood, reflex changes in the reactions to chemical stimuli occurred. This is true of stimuli that act on receptor fields (intestinal receptors, carotid zone chemoreceptors) far removed from the place of direct action of the stimuli.

There is no direct relationship between the degree of disturbance of circulatory reflexes of the zone of carotid sinus (was revealed in perfusion of isolated spleen by heterogeneous blood) and the changes in the blood pressure which are found at that time.

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