THE INVOLVEMENT OF THE CEREBRAL CORTEX IN THE REGULATION OF THE LEUCOCYTIC RESPONSE

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There can be no doubt about the involvement of the cortex in the regulation of the vascular system. The chief experimental work on this problem has been carried out by Soviet scientists. It was shown that the change in the functional condition of the brain induced by substances such as hypnotics, which may either excite or inhibit the cortical cells, will lead to a change in the nature of the leucocytic response to one or another stimulus [8, 10, 12, 13]. There is a great deal of evidence that the regulatory influence of the cerebral cortex on the vascular system is of a conditioned reflex nature [4, 5, 6, 11].

É. A. Asratyan and his co-workers [1] obtained indications that the cerebral cortex was an organ responsible for the unconditioned regulation of numerous functions. This pathway regulating the vascular system was first demonstrated by S. A. Chesnokova [14] and P. V. Simonov [9] who worked with É. A. Asratyan.

In studying the sensitivity of decorticate dogs to insulin, we have obtained results which throw light on the conditioned reflex influence of the cerebral cortex in regulating the leucocytic response.

METHOD

We used the method of decortication which has been adopted in Asratyan's laboratories. Investigations were made on the same dog before and after decortication. The operation was carried out in two stages, and we were therefore able to make studies after the removal of the cerebral cortex of one side. Six dogs were studied at all stages.

A redistributive leucocytic reaction was elicited by the intravenous injection of insulin, and studied for several hours. The experiments were carried out on fasting dogs 17 hours after they had fed, and on sated dogs two hours after they had taken 400 ml of milk and 100 g of bread.

RESULTS

The threshold dose of insulin which produced the minimal redistributive leucocytic response was much less than the amount required to induce hypoglycemia. For dogs with the brain intact, the first dose was approximately 0.02 units per kg body weight, whereas the second dose given intravenously was 0.05 units per kg.

After as little as 15 minutes, an intravenous injection of 0.02 units per kg of insulin into fasting dogs with the brain intact caused a reduction of the number of leucocytes in the bloodstream. The leucopenia was increased 30 minutes after the insulin injection. After one hour, the number of leucocytes in the blood began to increase, and after two hours it had returned to normal. In dogs which had fed, the leucopenic reaction to the threshold insulin dose was more clearly shown, and was superimposed on the nutritional leucocytosis. The reduction in the number of leucocytes was greater, and the return to the initial level occurred after approximately two hours.

After unilateral decortication, there was no change in the leucocytic response to a threshold insulin dose.

After removal of the second hemisphere, the intravenous injection of the same insulin dose caused a more profound and prolonged leucopenia. The number of leucocytes in the circulating blood was reduced to approximately one half, and did not return to the original level within two hours, as it did in the dogs with the brain intact (Fig. 1). The fed decorticate dogs gave a more marked leucocytic response to the same insulin dose, just as they did before the operation.

Therefore, after decortication, the sensitivity of the white cells of the blood to insulin is enhanced.

Further experiments showed that the threshold dose of insulin for the leucocytic response in decorticate dogs falls to approximately 0.006 units per kg body weight. The injection of this amount into dogs with intact brains caused no change either when the animals were fasting or when there was a nutritional leucocytosis, but when injected into decorticate dogs, it always induced a clear-cut leucopenic response. After 15 minutes, the number of leucocytes began to fall, and then returned to the original value (Fig. 2).

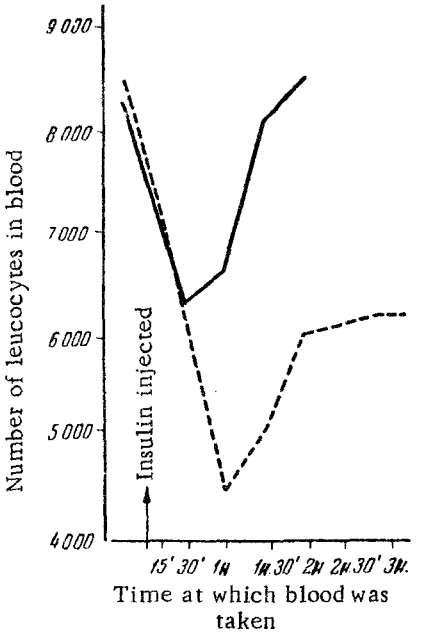

Fig. 1. Leucocytic response of the dog Shakal to a threshold insulin dose (1) before and (2) after decortication.

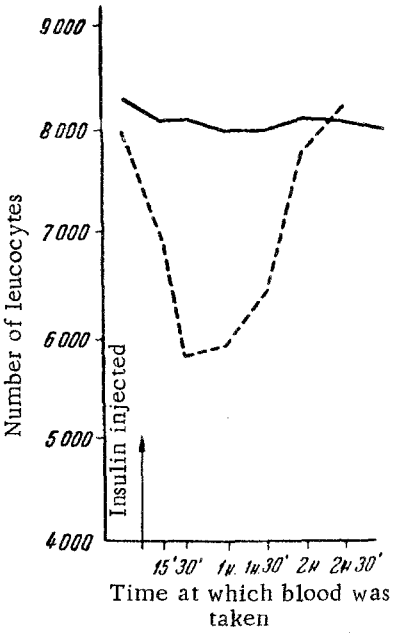

Fig. 2. Leucocytic response of the dog Shakal to an insulin dose 3 times less than threshold (the dose was threshold for the corticate dogs); (1) before and (2) after decortication.

The increased sensitivity to factors acting humorally in decorticate dogs was observed by É. A. Asratyan's co-workers also when studying other bodily functions. Thus I. K. Zhmakin [3] found an increased stimulating action of adrenalin and thyroxin on the oxidative processes in the tissues. S. A. Chesnokova [14] described a stronger leucocytosis after the injection of sodium nucleate. A. B. Gubar' and F. A. Oreshuk [2] describe how a preparation of dried bile caused a greater increase in the secretion of bile after decortication. According to A. A. Markova [7], the humoral phase of secretion of gastric juice with natural feeding is much stronger and more prolonged in decorticate than in intact dogs, and the secretion of gastric juice in response to such stimulants as histamine, carbocholine and dilute alcohol is markedly enhanced.

We have found that after decortication the threshold dose of insulin for the leucocytic response is reduced, and that the degree and duration of the leucopenia induced by a dose which is threshold for intact dogs is enhanced and prolonged; hence we deduce that there is a humoral link in the reflexes which cause a redistributive leucocytic reaction.

SUMMARY

Until now involvement of the cerebral cortex in regulating leucocytic reactions was considered doubtful. However recent reports indicate that regulation is chiefly of a conditioned reflex nature. We have regarded the cerebral cortex as the organ mediating higher unconditioned reflex regulation of various bodily functions, and have demonstrated some features of this regulation. Redistributive leucocytic reactions were induced by an intravenous injection of a threshold insulin dose into decorticate and into intact dogs. The reduction of the threshold value of the insulin dose required to elicit the leucocytic response after decortication, and the greater duration of the leucopenia induced by the insulin injection led us to conclude that the unconditioned reflex arc which induces the redistributive leucocytic reaction has a humoral link.

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