THE EFFECT OF HIGHER NERVOUS ACTIVITY DISTURBANCE ON HEMOGLOBIN METABOLISM

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The influence of the nervous system on hemoglobin metabolism has not yet been sufficiently explored. The data in the literature regarding the influence of the nervous system on the peripheral blood picture [1,2,3-7, 9, 10], in most cases, refers only to leukocytes. There is much less work regarding the influence of the nervous system on the red blood [1, 4, 5, 12] and in the few existing works, the authors barely mention the influence of the nervous system on hemoglobin decomposition intensity. As is known from the works of N. M. Nikolaev [8], G. F. Lang [6], Ya. G. Uzhansky [11] and others, there is a very close relationship between the processes of erythrocyte hemoglobin regeneration and decomposition. Therefore, in studying red blood changes, one must examine the indices of both the intensity of the hemolytic processes and the intensity of erythrocyte hemoglobin regeneration.

The purpose of this work was to study the effect of disturbance in higher nervous activity on the decomposition and synthesis of hemoglobin experimentally, in order to more nearly approach the explanation of the possible parts played by the nervous system in the pathogenesis of various anemias.

EXPERIMENTAL METHODS

To study hemoglobin metabolism, the intensity of hemoglobin decomposition was determined from the stercobilin excreted with the stool (by Terven's method) and the intensity of erythrocyte regeneration was determined from the amount of reticulocytes in the blood, the level of hemoglobin and the number of erythrocytes.

The experiments were done on 4 dogs; higher nervous activity was disturbed in 2 of the dogs by combining the food and defense unconditioned reflexes, and in the other 2 by combining the inhibitory and stimulatory processes after first producing conditioned defense, electric skin reflexes to the continuous sound of a bell and a differentiation to its interrupted ringing. A total of 16 experiments were done combining the unconditioned reflexes, and 62 were conducted with the second variant of the method.

During the experiments, daily stercobilin excretion was determined before during and after the combination. Examination of stercobilin content in the stool was done on a two-day amount of stool. A total of 124 stool analyses for stercobilin excretion were done on the 4 dogs. Blood was taken periodically from the ear before and many times during the experiment (44 blood analyses were done).

EXPERIMENTAL RESULTS

In the dog Belka, weighing 7.8 kg, higher nervous activity was disturbed by combining the food with

defense unconditioned reflexes. The dog was put in a chamber and given a trough of meat; then, the moment the dog touched the meat, his paw was given an electric shock. After the first combination of the food with the painful stimulation, the dog no longer touched the meat, but turned away and afterwards, whenever he saw the meat, began to yelp and tear away from the straps. It was very difficult to lead the dog into the chamber; it resisted, snapped and whined, but, nevertheless, the combination was produced daily.

Stercobilin excretion before the collision was from 1.9 to 2.7 mg per day. After the collision, stercobilin excretion increased and reached the maximal level (7.6 mg) about the 3rd-5th day, then decreased to 3.4 mg per day. The amount of reticulocytes increased from 3.5 to 6.5%, but the hemoglobin level decreased slightly – from 18.3 to 17.9 g%.

A combination was produced by the same means as in Belka in the dog Palma, which weighed 11.4 kg. After the very first combination of the food and defense unconditioned reflexes, the dog became very aggressive, pulled away from the straps and yelped. In this dog, stercobilin excretion was from 1.1 to 9.2 mg per day before the combination, but, by the 6th day of the experiment, it increased to 36.7 mg, i.e., was almost 4 times greater than before the combination. On the 7th-8th day, stercobilin excretion decreased to 13.1 mg per day. The amount of reticulocytes did not change. By the 6th day, the hemoglobin level had decreased from 19.8 to 17.9 g% (Fig. 1).

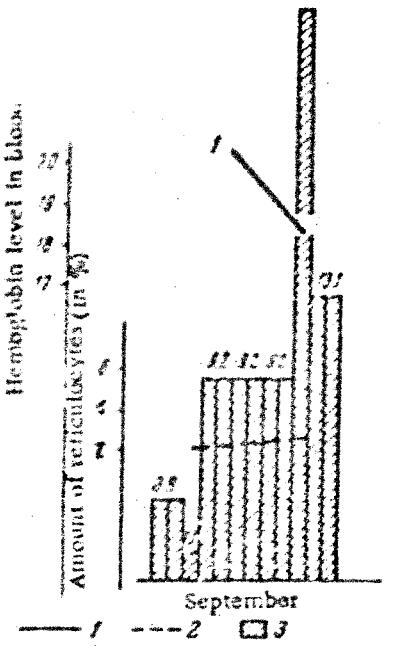

Fig. 1. Effect on hemoglobin metabolism in the dog Palma of combining the food and defense reflexes.
1) hemoglobin level in blood; 2) amount of reticulocytes; 3) stercobilin excretion in mg per day.

Therefore, when food and defense unconditioned reflexes were combined a temporary intensification of hemoglobin decomposition was observed: pigment excretion in the stool increased, and the level of hemoglobin slightly decreased.

In the dog Sharik, (6.8 kg) higher nervous activity was disturbed by colliding the stimulatory and inhibitory processes. A positive conditioned reflex to a continuous sound with an electric skin reinforcement was first produced in the animal. The answering reaction was expressed by the paw being jerked back, which reaction was kymographically recorded. A differentiation was produced to a bell which rang with interruptions (60 interruptions per minute). The action time of the conditioned stimulus was 20 seconds, and the time of the combined action of the conditioned and unconditioned was 5 seconds. The conditioned reflex developed slowly in this dog. It appeared first at the 8th combination, but was not permanent until the 63rd. The latent period of the conditioned reflex was from 2 to 8 seconds. The conditioned reflex was clearly expressed. We began to produce the differentiation in the dog after the 22nd experiment, and this appeared after the very first combination. During the development of the differentiation, the dog fell from time to time into an inhibited condition, and the conditioned reflex, at first, often disappeared.

When the experiment with the combination was begun, the conditioned reflex was firmly established in the dog, and the differentiation was absolute.

In the experiment with the combination, we gave the continuous bell sound for 20 seconds, then, immediately after this bell, we rang the interrupted bell for 20 seconds, then again the continuously ringing bell, and then the electric current reinforcement. Gradually the number of alternating conditioned stimuli was increased to 5, 7, 9 up to 25. At first, the experiments were done every day, then with small interruptions. The activity of the nervous processes in the animal was good; the dog reacted quickly to the continuous bell sound by jerking back its paw, did not move its paw to the interrupted bell, then jerked it back again to the continuous

bell sound. After frequent repetition of such experiments, it became very difficult to lead the dog into the chamber and tie it. It tore away, snarled and even bit. In the chamber, it yelped and ran about, but during the experiment worked very efficiently. By the 2nd month of the combination experiments, the dog was so much more aggressive that the experiments were sometimes disrupted, since sometimes the dog could not be gotten into the chamber.

In the first month of the combination experiment, no substantial disturbance in hemoglobin metabolism was evident, either in stercobilin excretion or in hemoglobin level. Only some fluctuation in the amount of reticulocytes was observed (sometimes increased to 9-10%). After the second month, hemoglobin decomposition became intensified, and stercobilin excretion often increased to 14.9, 15.8, or even to 29.1 mg per day (maximum before experiment was 10 mg). During this period, the amount of reticulocytes sometimes increased to 13, 18 and 19%. At first, intensified erythrocyte regeneration compensated for the increased rate of hemoglobin decomposition, and the hemoglobin level remained the same. Only 2½ months after the combinations were started, when there were as many as 25 alternations of the positive and inhibitory stimuli did stercobilin excretion increase to 29.1 mg, the hemoglobin level fall from 19.3 to 16.2 g%, and the amount of reticulocytes increase g more steadily to 10.5-18%. Then the combination was stopped, and after 2-3 weeks, pigment excretion decreased, and the hemoglobin level increased gradually until it reached the original level. However, the amount of reticulocytes remained high (8.5-10%) (Fig. 2).

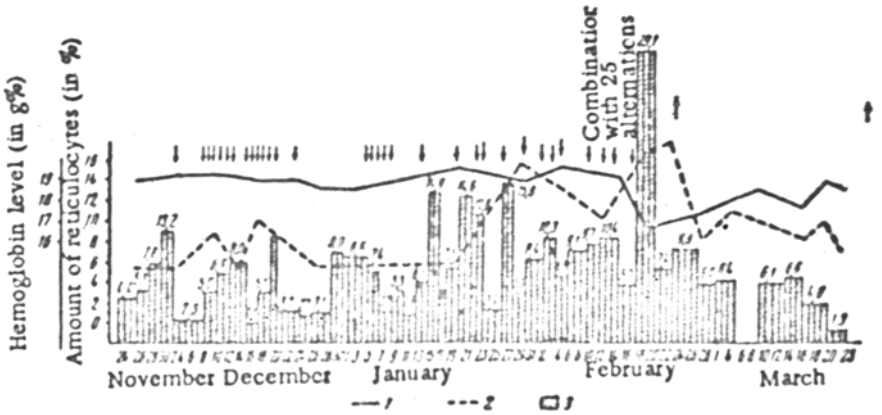

Fig. 2. Effect of combining the stimulatory and inhibitory processes on hemoglobin metabolism in the dog Sharik.
1) level of blood hemoglobin; 2) amount of blood reticulocytes; 3) stercobilin excretion in mg per day; arrows indicate the interruption in the work with conditioned reflexes.

A defense conditioned reflex was also produced in the dog Snezhka (5.3 kg) to a continuous bell sound and a differentiation to an interrupted bell sound. The conditioned reflex developed quickly, first appearing at the 5th combination. The latent period varied, from 1 to 10 seconds. The differentiation production was started early in this dog, when the conditioned reflex was not yet completely permanent (after 12 combinations in the development of the conditioned reflex). The differentiation developed very quickly, first appearing at the 2nd combination, and becoming absolute in almost all experiments after the 5th combination. The collision was produced in the same way as in the dog Sharik. The dog began to become aggressive as a result of the combination experiments.

Before the combination, the hemoglobin level was 18.3 to 19.7 g%, the number of reticulocytes 2 to 4 % and stercobilin excretion 3.5 to 5.8 mg per day. After the beginning of the combination experiments the hemoglobin level remained unchanged for a month. Stercobilin excretion increased the first days after the start of the experiment and, for the first week, was 7.8 to 10.5 mg. Later, from the 2nd to 5th weeks, periodic elevations in stercobilin excretion to 13.5-14.9 mg per day were observed in the course of its generally intensified excretion.

After the intensification of hemoglobin decomposition (stercobilin excretion was used as the criterion), an increase in the amount of reticulocytes was observed, to 8% on the 10th day and 10.5% on the 15th day, which indicated the activation of erythropoiesis. Due to the latter, the hemoglobin level remained steady for the first month.

But, 1½ months after the beginning of the combination, the hemoglobin level decreased to 1.5 g% of the original and continued to decrease, after a temporary increase to the normal level on the 56th day, reaching the minimum (3 g% lower than the original) after 2½ months. After the experiments were stopped, the hemoglobin level began to increase gradually.

The degree of fluctuation in the number of reticulocytes during the final 1½ months of the combination experiments was between 2.5 to 9.5%. One must point out that hemoglobin metabolism was observed to be unstable even some time after the combination experiments had ceased.

The last two experiments showed that an instability in hemoglobin metabolism appeared, with a predominance of the hemoglobin decomposition processes, due to the experiments colliding higher nervous activity in dogs.

The data presented show that the activity of the hemolytopoietic system depends greatly on the functional condition of the cerebral cortex and that the regulation of hemoglobin synthesis and decomposition is disturbed during the development of a neurotic condition. Hemoglobin decomposition at first increases, then erythrocyte regeneration is intensified, which causes the hemoglobin level of the blood to remain essentially the same for a certain period of time. Aggravation of the neurotic state leads to the disruption of this compensation, after which the hemoglobin level of the blood becomes considerably lower.

SUMMARY

The effect of higher nervous activity disturbances on hemoglobin metabolism in the dog was studied. The disturbances were caused by the combination of food and defense unconditioned reflexes and by a combination of inhibitory and excitatory processes, after a conditioned defense electric skin reflex and its differentiation had been previously formed. It was discovered that after the development of the neurotic state caused by such disturbances, hemoglobin decomposition in animals was intensified. Due to the compensatory augmented erythrocyte formation, the hemoglobin level of the blood did not materially change at the beginning, but with the progressive aggravation of the neurotic state, compensation failed and the hemoglobin level considerably decreased.

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