REFLEX REACTIONS FROM THE STOMACH ON THE BLOOD SYSTEM IN EXPERIMENTAL GASTRITIS

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The primarily redistributive leukocytic reactions which occur during the conditioned reflex phase of digestion are related to the reflex changes in the blood system which occur with the mechanical stimulation of the gastric mucosa. Changes in the number of leukocytes in the peripheral blood have often been observed experimentally in dogs in which the stomach was distended by means of a rubber balloon introduced through a fistula. [1, 5, 6, 8]. Such adequate stimulation of the gastric receptors has usually been observed to cause a rapid, but temporary increase in the number of leukocytes in the peripheral blood, the maximum increase occurring 1-2 hours after the inflation of the balloon; a phase in which the number of leukocytes decreases has sometimes been observed to precede this increase.* The fact that these fluctuations diminish after splenectomy [1] argues their redistributive nature. The reflex character of these changes in the peripheral blood is shown by the fact that they do not occur upon stimulation of gastric mucosa which has been smeared with cocaine. The reflex influx of "white blood" formed elements in large numbers into the organs of the abdominal cavity, which occurs the moment digestion starts, is evidently of definite biological importance, since many enzymes are carried by the leukocytes, especially by the neutrophils and lymphocytes.

Under pathological conditions, however, it is a priori supposed that the normal reflex reactions disappear or become distorted, and that new "pathological" reflexes appear.

Clinical studies have recently been done on the problem of "pathological" reflexes from the stomach on the blood system [2, 3]. However, judging from the literature available to us, there has been no experimental research on this problem. Nor has there been research on how the type and degree of expression of the gastric contractions affect these reflexes.

Our purpose in this work was to ascertain the nature of the reflex reactions from the stomach on the blood system under conditions of experimental gastritis, using data showing the changes in the leukocyte ratio and in the number of leukocytes in the peripheral blood.

EXPERIMENTAL METHODS

The experiments were done on 2 dogs with gastric fistulas. We used a rubber balloon filled with 500 ml of air to cause mechanical adequate stimulation of the gastric mucosa. The inflated balloon was left in the stomach for 3 hours. Blood was collected in a mélangeur from an incision made in the inner surface of the cochlea before the inflation of the balloon, and then 5 minutes, 30 minutes, 1 hour, 2 hours and 3 hours after the inflation. Two blood smears were taken – one before the inflation of the balloon and one 2 hours after the inflation.

* The author considers the use of the terms "digestive leukocytosis" and "digestive leukopenia" incorrect in this case, as it is a question of the relative fluctuations in the number of leukocytes as compared with a given original level.

The motor activity of the stomach was recorded with a manometrograph during the first 1½ hours of the experiment.

We used the method used in the Pavlov Laboratories to obtain experimental gastritis [4]: brief irrigation of the gastric mucosa with 1000 ml of a 10% solution of silver nitrate. One irrigation was done on the dog Reks and two, one month apart, on the dog Dichka. The mild inflammation thus induced can be examined as a model of the exogeneous form of acute gastritis [7]. The general condition of the dogs was not much changed after the irrigation of the gastric mucosa. Some vomiting was observed on the day of the irrigation, and subsequently a large amount of mucus was discharged from the fistula for a period of 7-10 days. The alimentary excitability of the animals did not suffer.

The experiments were conducted 14 and 15 hours after feeding, in an isolated chamber under uniform conditions.

Studying the leukocytic reflex reactions in dogs is complicated by the fact that there are considerable fluctuations in the leukocyte content of the peripheral blood of the animal under normal conditions [8, 9]. Because of this fact, 86 experiments were done on the two dogs over a period of 4 months to study the normal fluctuation range. Blood was taken at the same time intervals as in the main experiments with stimulation of the gastric receptors; the dogs were on the bench for a period of 2-3 hours.

EXPERIMENTAL RESULTS

It was established that the leukocyte content in 1 mm^3 of peripheral blood was subject in the control dogs to considerable fluctuations, both in the course of a single experiment and on different days. The extent of these fluctuations was as follows for the whole experimental period: from 6300 to 17,000 cells per 1 mm^3 in Reks, and from 6300 to 18,000 in Dichka. The difference between the largest and smallest number of leukocytes per 1 mm^3 during a single experiment was 400-8200 cells in Reks and 500-8300 cells in Dichka. The fluctuations of the leukocyte level during one experiment lessened considerably towards the end of the 4-month period, which fact seems to have been due to the development of extinctive inhibition to external stimuli. In comparison with the original level (at the start of the experiment), the number of leukocytes in the samples of blood taken subsequently, during the experiment, both decreased and increased; an increased number was more frequently observed (in Reks, 32 times out of 44 experiments, and 37 times out of 42 experiments in Dichka). The degree of increase was not great. Comparing the highest leukocyte content in a given experiment with the original level, we found the average increase to be 26.2% for Reks and 26.3% for Dichka. The leukocyte content could be highest during the beginning, middle or end of the experiment.

Our 53 experiments with the stimulation of normal gastric mucosa followed the basic pattern observed by most researchers – the leukocyte content increased after the balloon was inflated in the stomach. The average increase in the number of leukocytes was 55.4% in Reks and 57.9% in Dichka. In Reks the leukocyte level increased in all 25 experiments, in Dichka, in 25 out of 28 experiments. In experiments with a high initial leukocytosis, a pronounced decrease in the number of leukocytes was observed in all the blood specimens taken after the gastric stimulation.

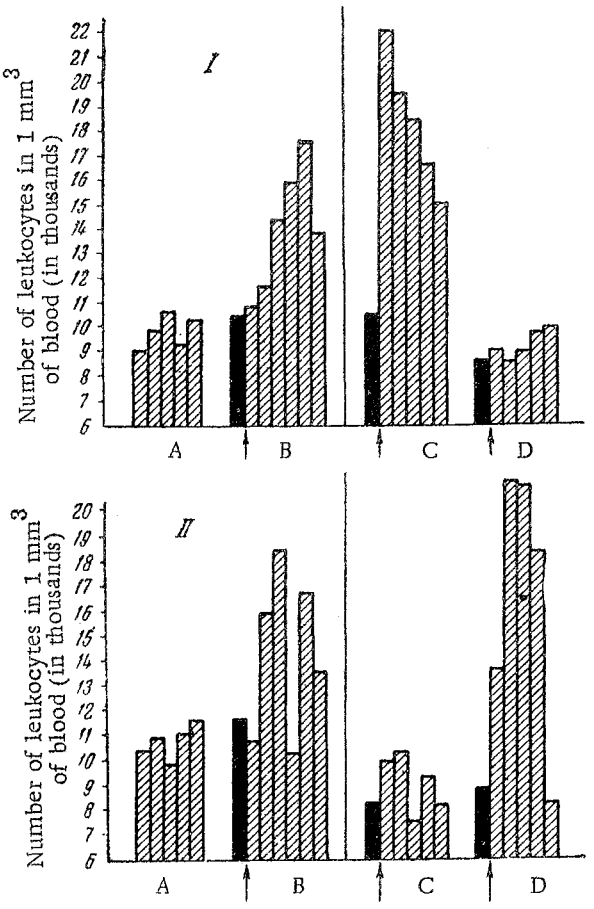
The highest leukocyte level was observed 30 minutes, 1 hour, 1 hour and 30 minutes and 2 hours after the inflation of the balloon.

We did not observe the initial "leukopenic" phase which has been described by several authors. The degree of decrease in the number of leukocytes after inflation of the balloon was not usually high in comparison with the original level (except for cases with a high original leukocytosis), and the decrease occurred at different times, as in the control experiments.

High leukocytosis, which persisted after inflation of the balloon, was observed on the 2nd day after the introduction of the silver nitrate solution.

With the further development of the experimental gastritis, two alternating forms of reflex leukocytic reactions were observed in the dogs in response to the gastric stimulation: 1) reaction weakly expressed or absent – the fluctuations in the number of leukocytes after inflation of the balloon, as compared with the original level, did not exceed the fluctuations in the majority of the first series of control experiments; this type of reaction was usually observed during the first 3-4 days; 2) reaction sharply expressed – high leukocytosis (20,000 - 23,000 cells

per 1 mm³), which did not occur in the experiments with the stimulation of normal mucosa, was observed after the inflation of the balloon.



Changes in the leukocyte count in the peripheral blood of the dogs Dichka (I) and Reks (II).
A) Without the use of stimuli; B) with stimulation of the normal gastric mucosa; C, D) stomach stimulated during the first 2 weeks in the development of gastritis. Black columns – original level of leukocyte count before inflation; arrow – moment of inflation.

These two forms of the reaction, the disappearance and the intensification of the reflex, occurred alternately for a period of one month after the burn in 8 out of 12 experiments on Reks and in 10 out of 12 on Dichka. As the pathological process abated, the normal type of reflex was reestablished, but again became distorted in Dichka after the second use of the silver nitrate.

Examples of normal reflex leukocytic reactions and their changes in experimental gastritis are shown in the graph.

Therefore, our experimental data agrees with the clinical observations which reported the intensification of reflex leukocytosis attending gastric stimulation in patients with hyperacid gastritis and the lack of a reaction with the hypacid form of gastritis [2]. In ulceration patients the reflex was even observed to be distorted [3].

The initial differential wbc had not changed much 2 hours after the start of the balloon inflation in the two dogs. Usually, a slight redistribution of the percentage content of segmented neutrophils and lymphocytes had occurred in the direction of a predominance of these or other cells. Less frequently (in 11 out of 27 experiments), a noticeable increase (7-11%) in the number of neutrophils was observed; in 6 of these 11 experiments, there was a shift to the left in the leukocyte ratio, i.e, the number of stab cells increased. High leukocytosis was not always attended by changes such as these, but could occur without any noticeable changes in the leukocyte ratio. This indicates that this leukocytosis is primarily redistributive in nature. Accelerated leukopoiesis does not seem to be the main factor behind the leukocytosis which occurs during the conditioned reflex phase of digestion.

After the introduction of the silver nitrate solution, the changes observed in the differential wbc of both dogs were extremely slight, both before and after stimulation. Neutrophilia and shift to the left were not observed even in cases with very high leukocytosis. It is difficult to explain these facts without morphological examination of the bone marrow.

After comparing the degree to which the motor activity of the stomach was expressed with the nature of the leukocyte reflex both before and after the stimulation, we were unable to establish any correlation between the two indices; a complete lack of any leukocytic reaction could be combined with pronounced gastric motor activity, or, conversely, high leukocytosis could be found after the inflation of the balloon with gastric motor activity completely inhibited. This again indicates the reflex nature of the changes which occur in the peripheral blood with stimulation of the gastric interoceptors. The mechanical factor (pressing blood from the spleen) does not play an important part.

The pathogenesis of acute and chronic gastritis is one of the problems of internal medicine. It is of definite value to the study of this problem to show the type of changes which occur in the reflex reactions of the affected organ. The changes which we have described in the leukocytic reflex during experimental gastritis evidently depend primarily upon the implication of the cardiovascular system in the pathologic reaction, since the leukocytic reactions are primarily redistributive.

SUMMARY

It was established that considerable reflex changes of the content of peripheral blood occur in dogs under conditions of experimentally induced gastritis. The reflexes were observed to disappear or to become intensified depending on conditions of the experiment.

Reflex changes in the content of the peripheral blood were observed in dogs as a result of adequate mechanical stimulation of the gastric receptors: the leukocyte count increases due to changed vascular redistributive reactions.

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