CHANGE IN HIGHER NERVOUS ACTIVITY AND BILE FORMATION IN DOGS WITH EXPERIMENTAL CHOLECYSTITIS

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K. M. Bykov and his colleagues have established that interoceptive signaling affects the function of various internal organs and body systems as well as higher nervous activity. The knowledge of interoception is very important to the explanation of the pathogenesis of diseases in many internal organs, including the liver and gallbladder. As histological studies have shown [8], the gallbladder has an extensive receptor apparatus. Physiological studies have disclosed that when the receptors of a normal gallbladder are mechanically stimulated, the higher nervous activity of animals changes [2,5,6,7]. When mechanical, thermal or chemical factors act upon the mucous membrane of the stomach or intestine, the secretion and motority of these organs changes [1,3,-9,10].

Disturbances of higher nervous activity were obtained in experimental gastritis and stomach ulcer [4].

We studied the condition of the cerebral cortex in dogs with experimental cholecystitis and the functional condition of the gallbladder mechanoreceptors before and after cholecystitis.

EXPERIMENTAL METHODS

The experiments were done on two dogs with a developed and fixed stereotype of exteroreceptive and interoreceptive conditioned reflexes.

The dogs had fistula of the gallbladder with a ligated common bile duct. The higher nervous activity in the dog Sekret was classified as the weak type, that in the dog Alfa, as a strong variation of the weak type.

We determined the functional condition of the gallbladder mechanoreceptors by the changes in the higher nervous activity during mechanical action on the gallbladder. A rubber balloon was inserted into the gallbladder cavity through the fistula (size of ballon: 4 x 2 cm). After the start of the experiment, 25 ml of water with a temperature of 35° was introduced into the ballon. The balloon was left filled in one dog until the end of the conditioned reflex experiment, but, in the other, only during the action of the first two conditioned stimuli, from then on the interoceptive, conditioned reflex from the gallbladder followed. Inflammation of the gallbladder (cholecystitis) was produced by one or two irrigations of its mucous membrane with a 5% solution of silver nitrate.

EXPERIMENTAL RESULTS

The first series of experiments – stimulation of the gallbladder mechanoreceptors – was begun on a background of normal higher nervous activity in the animals. When the gallbladder mechanoreceptors were stimulated, a change occurred in the higher nervous activity, mainly expressed by a decrease in the potency of the conditioned reflexes. In many experiments, one could observe the appearance of the regular and paradoxical phases in the activity of the grey matter cells and the disinhibition of the differentiation. The unconditioned reflexes were essentially unchanged. In the intervals between the experiments with bladder stimulation, higher nervous activity in the dogs returned to the original level.

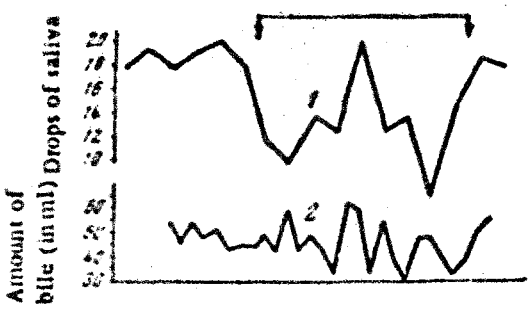

Fig. 1. Changes in higher nervous activity and bile secretion under the influence of stimulation of the gallbladder mechanoreceptors in Alfa.
1) result of positive conditioned reflexes; 2) bile secretion to meat (100 g). The space between the arrows shows the experiments stimulating the gallbladder mechanoreceptors.

The changes in the bile formation function of the liver in the dog during the experiments with gallbladder mechanoreceptor stimulation were characterized by fluctuations in the amount of bile secreted in response to food stimuli (Fig. 1).

The data we obtained agree with those of other authors who studied the influence of gallbladder receptor stimulation on higher nervous activity [2,5,7].

The second series of experiments – inflammation of the gallbladder – was also began with normal higher nervous activity in the animals.

After one irrigation of the gallbladder mucous membrane with the 5% silver nitrate solution (15 ml), a long disturbance of the higher nervous activity occurred in the dog Sekret, and it was especially strongly expressed the first month after the irrigation. The higher nervous activity disturbances were expressed by a decrease in the result of the positive conditioned reflexes to 2-6 drops instead of the original 9-12. The conditioned reflexes remained weakly expressed for 5 weeks. During that period, the regular and paradoxical phases in the activity of the cerebral cortex cells were clearly evident. In many experiments, the differentiation was disinhibited and exceeded the potency of the positive conditioned reflex. The animal refused to eat in almost every experiment. The product of the unconditioned reflexes was reduced to 30 drops of saliva in some experiments instead of the initial 120-130 drops. Along with the bile, a serous-purulent discharge was excreted from the gallbladder. The bile secretion decreased during food ingestion; for example, 25 ml of bile (average of 13 experiments) was secreted to meat in 4 hours instead of the normal 30 ml. After 5 weeks, the dog was given $1\frac{1}{2}$ months rest, after which it no longer refused food during the experiments. The higher nervous activity began to be gradually restored and finally, after 5 months, returned to the original level.

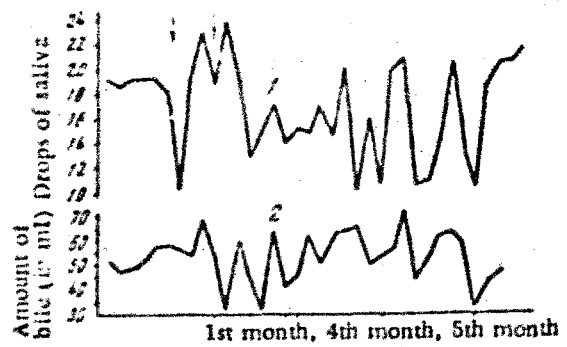

Fig. 2. Changes in higher nervous activity and bile excretion during experimental cholecystitis in Alpha. The symbols are the same as in Fig. 1. The arrows show the experiments with irrigation of the gallbladder mucous membrane with a 5% solution of silver nitrate.

In Alfa, the first irrigation of the gallbladder mucous membrane with the 5% silver nitrate solution first caused the degree of the conditioned reflexes to decrease (their product decreased from 18-19 drops to 10), but then caused it to increase (to 23 drops). Two weeks after the first irrigation, a second was done. It first caused a temporary increase, then a decrease of the conditioned reflexes (to 13-15 drops); the regular and paradoxical phases were observed in the activity of the cerebral cortex cells. The unconditioned salivasecreting reflexes were essentially unchanged. Disturbances of higher nervous activity were also observed after the $1\frac{1}{2}$ month interruption in the work, and lasted on the whole for a five month period (Fig. 2, 1).

Changes in the bile forming function of the liver, during gallbladder inflammation, were expressed by sharp fluctuations in the amount of bile secreted to food stimuli. For example, 35-70 ml of bile were secreted to 100 g of meat for 4 hours of the experiment instead of the original 45-55 ml (Fig. 2,2). The bile was cloudy, with a large quantity of mucus and streaks of blood.

This data indicates that impulses leaving the pathologically altered organ change the higher nervous

activity and that, possibly in connection with this, the functions of the various organs are altered. The secretory function of the liver particularly changes, as our studies showed.

Gallbladder motoricity during cholecystitis was also studied. The contractions were recorded by a water-air transmission and a Marey's capsule on a kymograph tape before and after the food stimulus had been given (2 egg yolks). While the inflammation was developing in the gallbladder, the motor activity of the gallbladder was disturbed in both dogs (Fig. 3). The rhythmic contractions of the gallbladder lessened considerably during the period of inflammatory phenomena in the bladder. This was evident even before the food stimulus had been given, but especially after ingestion of the two egg yolks.

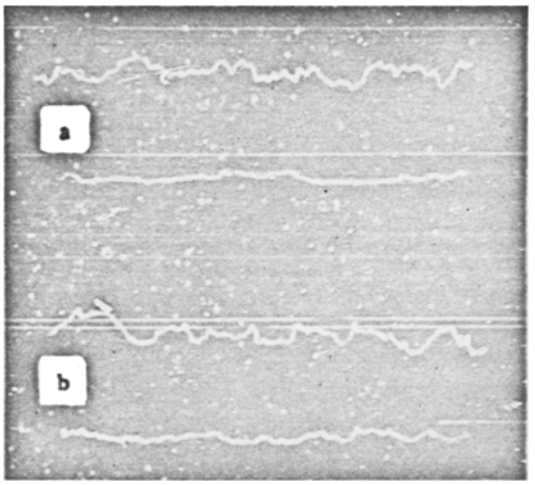

Fig. 3. Change in gallbladder motoricity during experimental cholecystitis in Sekret (a) and in Alfa (b).
1) motoricity of the bladder 10 minutes after ingestion of 2 egg yolks, before cholecystitis; 2) the same with cholecystitis.

In a third series of experiments, we examined gallbladder reception after cholecystitis. It could be proposed that inflammation decreases the sensitivity of the gallbladder receptors. However, the experiments showed that the reverse was true. In Sekret, a second stimulation of the gallbladder mechanoreceptors by the same stimulus as was used in the first series (25 ml of water) caused change in the higher nervous activity. The degree of the conditioned reflexes decreased, and the differentiation was disinhibited.

In Alfa, even after 5 months, the potency of the conditioned reflexes and the degree of bile formation was unstable. The bile secreted contained much mucin. Stimulating the bladder mechanoreceptors by inflating the balloon caused, at that time, more agitation of the animal than in the first series of experiments and vomiting motions. From the standpoint of the higher nervous activity, a sharp suppression of the positive conditioned reflexes was observed (in one experiment, they disappeared).

Therefore, with experimental cholecystitis, we observed that higher nervous activity was suppressed for a protracted period and that the bile-forming function of the liver was also disturbed. Five months after the irrigation of the gallbladder mucous membrane with the 5% solution of silver nitrate, the sensitivity of the gallbladder receptors was slightly increased.

SUMMARY

Two dogs with fistulae of the gallbladder and established stereotypes of salivary conditioned reflexes were studied. Observations demonstrated that in case of cholecystitis caused by one or two irrigations of the mucous membrane of the gallbladder with a 5% solution of silver nitrate, positive conditioned reflexes were lowered, differentiation was disinhibited for a long time (several months), bile formation in the liver was decreased, and the motor activity of the gallbladder was lowered.

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* In Russian.