NERVOUS REGULATION OF GALL BLADDER MOVEMENTS

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Experiments on unanesthetized dogs using the method of cholangiography showed that stimulation of the greater splanchnic nerve causes relaxation (sometimes after a transient contraction) of the gall bladder and stimulates the inflow of hepatic bile into the gall bladder. Stimulation of a dorsal esophageal ramus of the vagus nerve outside the phase of digestion stopped the inflow of hepatic bile into the gall bladder and accelerated contraction of the organ and outflow of cystic bile into the duodenum during the digestive phase.

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Two principal views are held at the present time of the mechanism of regulation of functions of the biliary system. Some authors consider that the humoral regulation of its functions is proven [11-13, 16], while others consider that the mechanisms of regulation of these functions is predominantly nervous [6-10, 14, 15, 17, 19].

We have studied the role of the autonomic nervous system in regulation of functions of the extrahepatic portion of the biliary tract in unanesthetized dogs with an intact biliary apparatus under chronic experimental conditions.

EXPERIMENTAL METHOD

Four dogs were used in the experiments. The biliary apparatus was studied by the method of excretory cholecystography [4]. Serial roentgenograms were taken at intervals of between 20-30 sec and 10-20 min. The experiments lasted 2-5 h.

Electrodes were introduced into the greater splanchnic nerves, the hepatic branch of the solar plexus, and also in the branch of the vagus nerve running to the solar plexus by a method suggested previously [2]. The nerve fibers were stimulated by square pulses, 0.1 msec in duration and with different frequencies (5, 10, and 20/sec). The stimulation voltage was 7-9 V and the duration of each period of stimulation 3-5 sec. In individual cases afferent or efferent impulse activity was recorded in the above-mentioned fibers [3-5].

EXPERIMENTAL RESULTS

In 11 of 23 experiments stimulation of the greater splanchnic nerve at a time of absence of digestion caused a rapid increase in volume of the gall bladder (Fig. 1, I) and an increase in the inflow of fresh hepatic bile into it. These changes continued for 20-30 min. Periodically the ampulla of Vater became dilated. Almost throughout the period of observation, a small quantity of bile was discharged into the intestine. The dimensions of the common bile duct were unchanged. In another 11 cases relaxation of the gall-bladder was preceded by a transient increase in its volume which lasted for 2-4 min. The gall bladder then began to enlarge and after a period of 15-20 min returned to its initial volume. Only in one case was a transient and slight contraction of the gall bladder not followed by relaxation. After injection of 1 ml adrenalin (1:1000) the relaxation of the gall bladder caused by stimulation of the greater splanchnic nerve was more marked (from 28-54 cm^3). It continued for 15 min, after which the volume of the gall bladder slowly returned to its initial value (Fig. 1, II). In this period the magnitude of the "spontaneous" efferent impulse activity in the mixed hepatic branch of the solar plexus and of afferent impulse activity in the esophageal ramus of the vagus nerve showed a clear decrease (Fig. 2).

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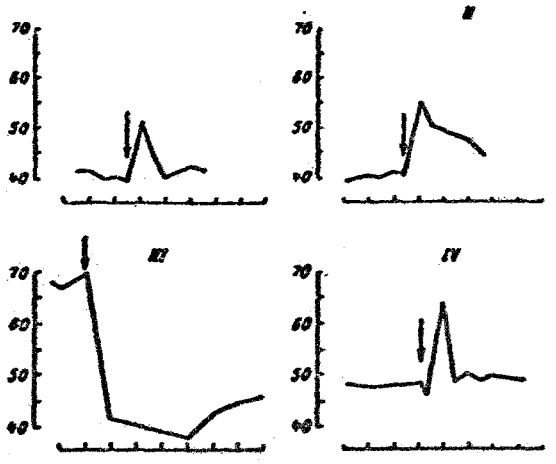

Fig. 1. Changes in volume of gall bladder of waking dog during stimulation of greater splanchnic nerve during absence of digestion under normal experimental conditions (I), after injection of 1 mg adrenalin (II), during stimulation of branch of vagus nerve running to solar plexus (III), and during simultaneous stimulation of both nerve trunks (IV). Ordinate, volume of gall bladder (in ml); abscissa, time (each marker 5 min).

Stimulation of the splanchnic nerve during the phase of digestion (50 g raw egg yolks) caused relaxation of the gall bladder and lengthened the latent period of onset of its contractions to 45-60 min.

Stimulation of the branch of the dorsal esophageal ramus of the vagus nerve to the solar plexus during absence of digestion stopped the inflow of hepatic bile into the gall bladder and accelerated the flow of bile into the duodenum. In the phase of digestion, stimulation of the vagus nerve accelerated contraction of the gall bladder (Fig. 1, III).

After stimulation of the mixed branch from the solar plexus to the biliary tract, in 11 of 13 experiments the gall bladder shadow diminished in size 1-2 min after the beginning of stimulation and the outflow of bile into the duodenum was observed. In the period of digestion, stimulation of the nerve strengthened contraction of the gall bladder without a recordable latent period. In one experiment, in response to electrical stimulation (2 V, 5/sec) relaxation of the gall bladder developed, while in one experiment no changes were observed in the state of the biliary system after stimulation.

Stimulation of the mixed branch running directly to the neck of the gall bladder caused spasm of the neck region and of the cystic duct which stopped emptying of the gall bladder for 23-25 min after administration of yolk. In the stage of absence of digestion, stimulation of this nerve caused contraction of the neck of the gall bladder and of the cystic duct.

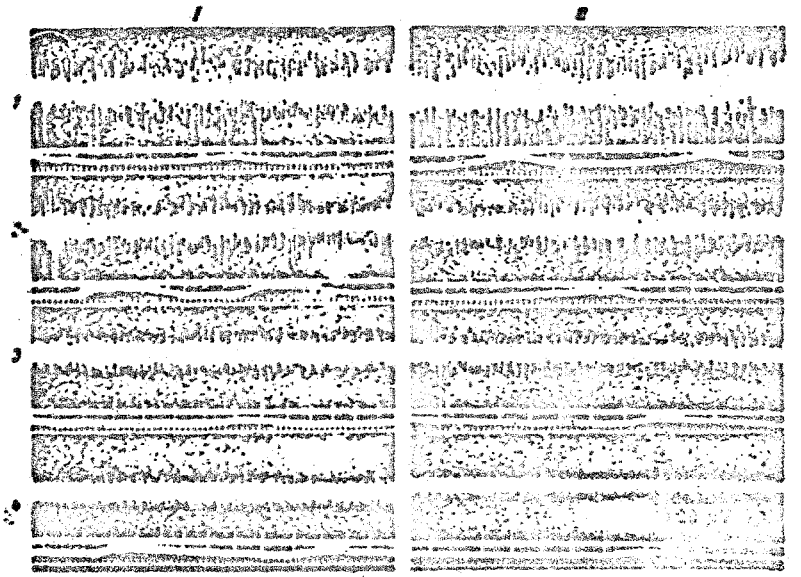

Fig. 2. Changes in "spontaneous" afferent impulse activity in esophageal ramus of vagus nerve (I) and efferent impulse activity in mixed hepatic branch of solar plexus (II) in waking dog after injection of 1 mg adrenalin: 1) background activity; 2) 1 min, 3) 5 min, 4) 10 min after injection. From top to bottom: neurogram, ECG, pneumogram, time marker (10 cps).

The action of simultaneous stimulation of the splanchnic nerve and the branch of the vagus nerve running to the solar plexus was tested. After the end of stimulation contraction of the gall bladder began (by 2-3 cm^3 in the course of 3-5 min), after which marked relaxation developed (by 13-15 cm^3) in the course of 12 min (Fig. 1, IV), and in one experiment the gall bladder relaxed by as much as 25 cm^3 in the course of 25 min. This was followed by a slow return to its initial state. Stimulation of both nerves at the time of eating caused profound and rapid relaxation of the gall bladder (by 20-23 cm^3 in the course of 10-20 min) and lengthened the latent period of onset of its contractile activity to 25 min.

All these experiments showed that the intact biliary apparatus possesses a well developed regulatory system. This was shown by the constant return of the biliary system to its initial state after stimulation of the nerves. The clearest responses of the biliary system were obtained after stimulation of moderate frequency (5/sec; amplitude not exceeding 8 V).

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