HORMONAL REGULATION OF MOTOR ACTIVITY OF THE DIGESTIVE ORGANS

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Experiments on intact dogs using a roentgenologic method showed that injection of hormonally active factors from urine (urocholecystokinin) or blood serum (cholecystokinin) from a donor dog stimulates peristaltic activity of the stomach and duodenum in the recipient dog, modifies the shape of the gall bladder, and causes contraction of its neck and the periodic expulsion of bile into the intestine.

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Cholecystokinin, discovered in 1928 [8], causes contraction of the musculature of the gall bladder and relaxation of the sphincter of Oddi. The action of cholecystokinin of the biliary system has been investigated experimentally many times [2, 7, 8]. Data concerning the effect of cholecystokinin on functions of other digestive organs are contradictory, possibly because these investigations were usually conducted as acute experiments [6].

It was discovered in 1957 that the urine contains a factor, named urocholecystokinin, possessing cholecystokinin activity [9]. Experimental investigations [3-5, 10] showed that as the concentration of cholecystokinin in the blood rises, so also does the concentration of urocholecystokinin in the urine, reaching a maximum 1.5-2 h after the taking of food. The same workers found that urocholecystokinin increases the pressure within the gall bladder. Gol'tyakova and Popova [1] found that reflex contraction of the gall bladder is dependent on the urocholecystokinin level. These are the only data available concerning the action of urocholecystokinin on the digestive organs. Experiments to study the action of urocholecystokinin have been carried out under acute conditions on anesthetized animals.

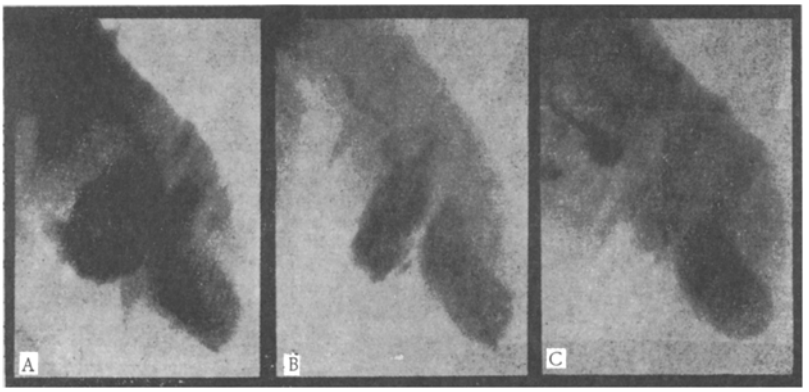

Fig. 1. Emptying of the stomach (dog Belyi) before (A) and 5 min (B) and 15 min (C) after injection of blood serum.

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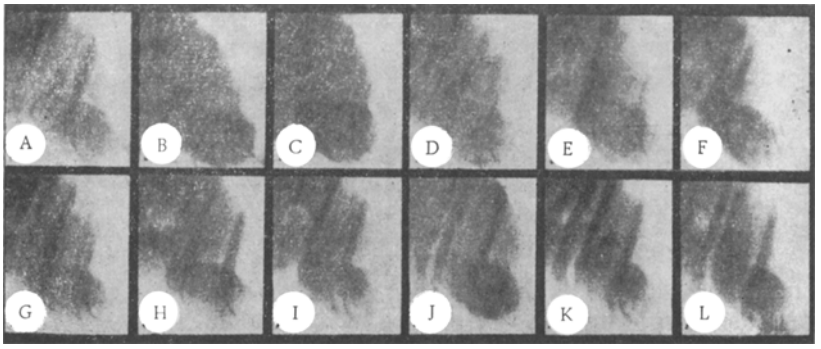

Fig. 2. Changes in shape of the gall bladder and expulsion of bile into the duodenum of dog Bek after injection of hormonally active factors of urine. A) Before injection; B) 1 min; C) 2 min; D) 3 min; E) 4 min; F) 5 min; G) 6 min, H) 7 min, I) 10 min, J) 13 min, K) 15 min, M) 20 min after injection of urine.

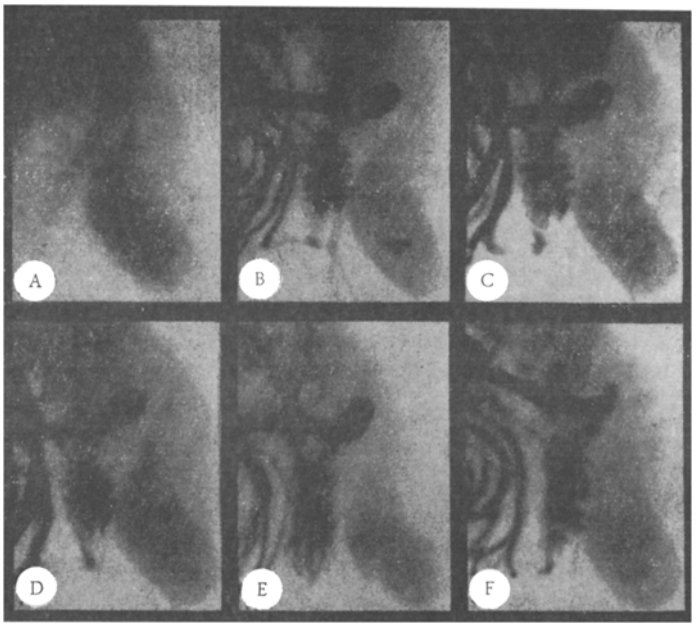

Fig. 3. Inflow of bile into gall bladder of dog Belyi after injection of hormonally active factors of urine. A) Before injection; B) 3 min; C) 5 min; D) 6 min; E) 10 min; F) 30 min after injection of urine.

The object of the present investigation was to study the role of cholecystokinin and urocholecystokinin in the regulation of coordinate motor activity of the biliary system, the stomach, and the duodenum.

EXPERIMENTAL METHOD

Chronic experiments were carried out on four noninbred dogs (males). No purified hormones were available, and the method of Svatos [10] was therefore used—serum and urine of animals fed on egg yolks were injected. Two series of observations were made: injection of the hormonally active factor from urine (urocholecystokinin) into satiated animals and injection of serum (containing cholecystokinin) into a satiated animal. Experiments in which urine and blood of fasting animals were injected acted as controls. Salts were removed from the urine by dialysis. The experiments were carried out as follows. The radioopaque contrast material bilignost (0.2 ml/kg body weight) was injected into a fasting recipient dog. As soon as the

gall bladder shadow became homogeneous (on the average 180 min after injection of the contrast material) a control film was taken and 10 g of a suspension of barium sulfate in water was given, after which a second film was taken. The dog then received an intravenous injection of 10-15 ml of urine or serum from the donor dog 10-15 min after feeding on egg yolks (according to data in the literature, this is the time when the cholecystokinin concentration in the blood reaches a maximum). Urine was collected 1.5 h after feeding on egg yolks (maximum concentrations of urocholecystokinin in the urine). After intravenous injection of urine of serum, serial roentgenograms or combined motion picture-roentgenographic investigation was carried out for 15 min, and after 20, 30, 45, and 60 min. The roentgenograms were taken with the TUR-1000 apparatus at a voltage of 60-62 kV, current 100-120 mA, and exposure 0.05 sec. For the combined motion picture-roentgenologic investigation, a Philips EOP x-ray image intensifier was used.

EXPERIMENTAL RESULTS

Intravenous injection of urocholecystokinin or cholecystokinin simultaneously modified the motor activity of the stomach, duodenum, and biliary system.

In all experiments, after the first 1-3 min, peristalsis of the stomach and duodenum began or increased. After injection of the hormonally active factors from the urine or blood serum, the combined roentgenologic investigation revealed a shortening of the duration of the peristaltic wave to 3-5 sec (compared with 12-14 sec in control experiments). Meanwhile their number increased to 10/min (compared with 5/min in the control experiments). The time of opening of the pyloric canal 3-4 min after injection of urine or serum was lengthened to 3-4 sec (compared with 1-2 sec in the controls). Increased peristalsis was accompanied by a rapid emptying of the stomach contents. Usually the stomach was empty after 6-10 min (Fig. 1).

Simultaneously with changes in gastric and duodenal motor activity, changes were also observed in the biliary system. Characteristically, bile was expelled into the duodenum. Usually this expulsion was periodic in character, starting 1-3 min after injection of the hormonally active factors of urine or blood, and continued on the average for 15-20 min. Expulsion of bile into the duodenum 20 min after injection was reduced or stopped altogether.

Simultaneously with expulsion of bile into the duodenum, in many experiments the shape and size of the gall bladder underwent changes (Fig. 2). Rapidly alternating periods of reduction in size and broadening of the gall bladder shadow, changes in its length, and inward bulging of its wall were observed. After intravenous injection of the hormonally active factors of urine and serum, changes were nearly always observed in the region of the gall bladder neck: contractions or a decrease in the intensity of its shadow. Usually changes in the shape of the neck and expulsion of bile into the intestine occurred at the same time as the expulsion of the gastric contents.

In some experiments, an inflow of hepatic bile into the gall bladder was observed after injection of urine or serum (Fig. 3). The inflow of bile began after a short latent period (1-3 min) and it sometimes continued up to 30 min. In some cases it was so considerable that it was not compensated by expulsion of bile into the duodenum.

In control experiments no changes were observed in the functions of the biliary system or of the stomach and duodenum.

The results indicate that injection of hormonally active factors of the urine or blood serum have complex and simultaneous action on motor functions of the digestive organs. Initial changes in shape and size of the gall bladder and the expulsion of bile into the duodenum may be due not only to reflex, but also to hormonal factors.

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