TONUS OF LUTKENS' SPHINCTER UNDER NORMAL CONDITIONS AND IN EXPERIMENTAL FEVER

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We previously established [3] that bile secretion is depressed in febrile animals; no material changes were noted in the discharge of bile into the intestine. The fact that, on an empty stomach, in animals with Dastre's biliary fistula and with the common bile duct isolated by I. P. Pavlov's method bile was regularly released through the biliary fistula, no more than 1.5 ml of bile being periodically liberated from the fistula in the duct, requires further investigation. This relationship was greatly altered if the animal was presented with an alimentary stimulus. In this case the greater part of the bile was directed to the intestine and poured through the fistula in the duct, only a small quantity of mucus being released from the biliary fistula. These data indicated active contraction of the biliary duct and agreed with the observations of G. V. Volborth [5, 6].

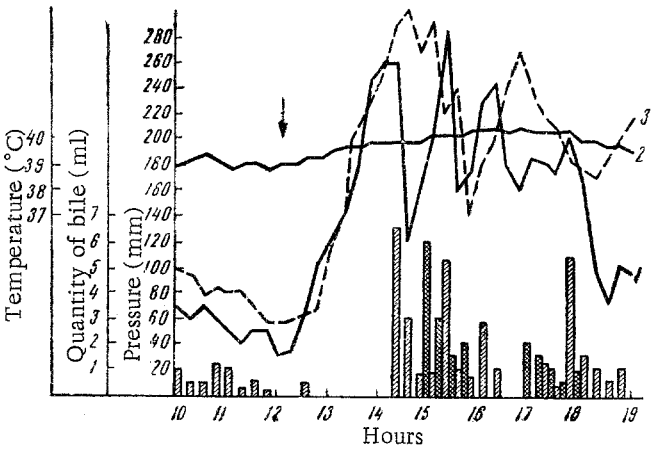

Fig. 1. Changes in the tonus of Lutkens' sphincter in the dog Malysh on an empty stomach and after eating meat, under normal conditions and in experimental fever. 1) Pressure in control experiment; 2) body temperature; 3) pressure in experiment involving fever. The shaded columns represent the quantity of bile obtained from the biliary fistula in the control experiment and the cross-hatched columns represent the quantity of bile obtained from this fistula in the experiment involving fever. The arrow indicates the time at which Bac. mesentericus was administered and the alimentary stimulus was applied.

First Aschoff [7, 8] and then Lutkens [11] called attention to the presence of circular muscle fibers in the region where the neck of the gall bladder passes into the cystic duct. Lutkens stated quite definitely that these fibers serve as a sphincter which regulates the filling and emptying of the gall bladder. However, the author conducted no physiological investigations which might have confirmed this hypothesis. There later appeared works by Nobauer and Boyden [12] in which the existence of this sphincter was denied.

In 1955 E. D. Buglov [2] demonstrated in acute and chronic experiments that the tonus of Lutkens' sphincter increases when digestion begins.

We observed the same changes as E. D. Buglov and in this connection we conducted additional investigations to study the tonus of Lutkens' sphincter under normal conditions and in experimental fever.

EXPERIMENTAL METHOD

The experiments were conducted on dogs with Dastre's biliary fistula and the common bile duct was isolated by Pavlov's method. In order to evaluate the tonus of Lutkens' sphincter we recorded the pressure in the biliary tract. For this purpose a glass cannula was inserted

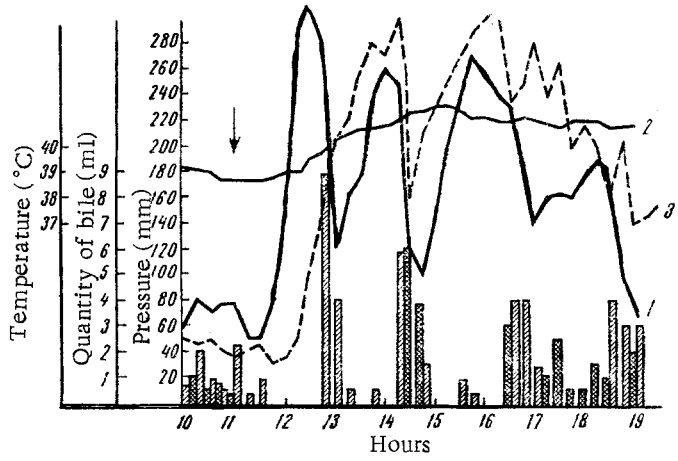

Fig. 2. Changes in Lutkens' sphincter on an empty stomach and after drinking milk, under normal conditions and in experimental fever. The key is the same as for Fig. 1.

into the orifice of the common bile duct and connected to a manometer tube. The zero point of the manometer was set for the level of the orifice of the isolated common bile duct. All the experiments were conducted with the biliary fistula open (the pressure in the gall bladder equaled atmospheric pressure). The pressure was recorded every 15 min on an empty stomach and then after eating alimentary stimulants (100 g of meat, 600 ml of milk, and 50 g of egg yolks); this was done both under ordinary conditions (control experiments) and during experimental fever. The fever was induced by subcutaneous injection of a low-toxicity autoclaved buillion culture of Bac. mesentericus (1-2 ml/kg). In some of the experiments the alimentary stimulus was applied immediately after injection of the culture, while in others it was applied at the height of the rise in body temperature. The latter was measured with a copper-constantan thermocouple, whose working junction was inserted into the rectum to a depth of 6-8 cm before the experiment.

EXPERIMENTAL RESULTS

On an empty stomach the pressure varied from 40 to 108 mm H_2O over the 2-hour recording period, exhibiting a clear tendency to decrease as the experiment progressed. A small quantity of bile was released from the biliary fistula.

After eating meat the liberation of bile from the biliary fistula ceased and the pressure in the system rose (Fig. 1). This indicates that when digestion begins the tonus of Lutkens' sphincter increases, the muscle closes the cystic duct, and all the bile secreted is directed to the duodenum. In the control experiment the tonic stress on the sphincter was succeeded by relaxation when the pressure reached 260 mm and the bile accumulated in the system was directed into the gall bladder and then out through the fistula. This was followed by another rise in pressure corresponding to an increase in sphincter tonus. When the pressure reached 280 mm the sphincter once more relaxed and bile was released from the biliary fistula. As the experiment proceeded the tonic stress on the sphincter was periodically succeeded by relaxation, the pressure in the system tending to decrease.

In the same dog (Malysh) the tonic stress on the sphincter in the febrile state was characterized by a sustained high pressure (325 mm). The subsequent variations in pressure remained at a level higher than that observed in the control experiments. Similar data were obtained for the other dogs.

With the sphincter relaxed drinking milk (Fig. 2) caused an increase in sphincter tonus both in the control experiment and in the febrile state. When the sphincter relaxed and opened, the bile passed into the gall bladder and out through the fistula. On comparison of the curves it is easy to see that the sphincter maintained a higher pressure under febrile conditions than in the control experiment. The tonus of the sphincter reached its maximum after 1.5 h in the control experiment and only after 3.5 h in the febrile state. The sphincter tonus in the febrile animal remained at a higher level over the subsequent observation period.

After eating egg yolks the tonic stress on the sphincter was quite high in the febrile animal (325 mm) and persisted at a rather high level throughout the entire experiment.

In the experiment in which the alimentary stimulus was applied at the height of the rise in body temperature the sphincter tonus rose slightly after administration of the pyrogen. It reached its maximum 3 h after alimentary stimulation and then began to decrease, bile being released from the biliary fistula (Fig. 3). During the next few hours the tonus remained at a level higher than was observed in the control experiments.

Essentially similar data were obtained when the animals were fed meat and milk at the height of the rise in body temperature.

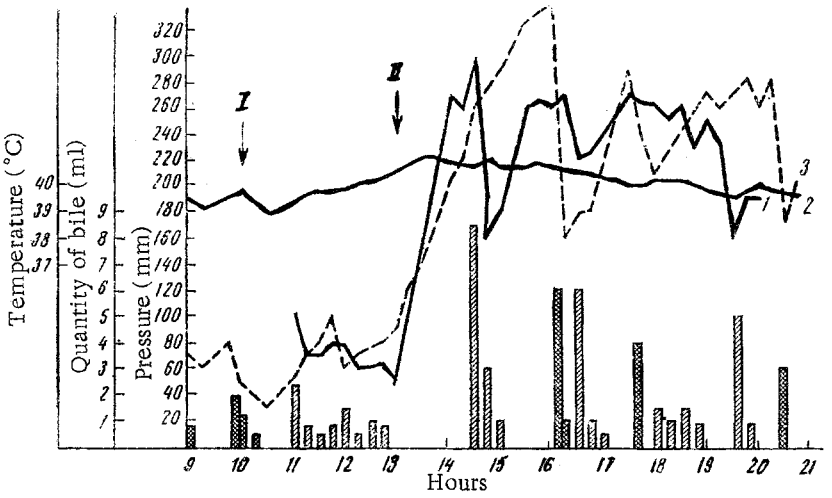

Fig. 3. Changes in Lutkens' sphincter on an empty stomach and after eating egg yolks, under normal conditions and in experimental fever. The key is the same as for Fig. 1. Arrow I indicates injection of the Bac. mesentericus culture and arrow II indicates application of the alimentary stimulus.

During the 2-3 days after the fever disappeared the sphincter tonus was characterized by instability and high lability. It later returned to approximately its initial level and stabilized within the range characteristic of the control experiments.

The data cited indicate the important physiological role of Lutkens' sphincter. When the biliary tract is intact and no digestion is occurring the sphincter is in the relaxed state, which promotes accumulation of bile in the gall bladder. As soon as the bladder is filled and it becomes difficult to store any more bile in it, the accumulated bile is released into the intestine [1]. When digestion begins the first portions of bile are released from the gall bladder and the subsequent increase in the tonus of Lutkens' sphincter causes the bile produced by the liver to be transferred directly to the duodenum. The rate of bile flow depends on the extent to which it is secreted, the hydrostatic pressure in the system, and the contractile activity of the biliary ducts.

These relationships are maintained in febrile animals. During the initial period of the fever, before any marked depression of bile formation is observed, the tonus of Lutkens' sphincter increases after eating to the same extent and at the same rate in experiments in which egg yolk and meat are used as the alimentary stimulants and rises somewhat more slowly in experiments where the animals are fed milk. During the maximum rise in body temperature and its stabilization at a high level, which is usually accompanied by attenuation of bile formation, sphincter tonus remains high.

Using a similar fever model in animals and observing sick and healthy persons vaccinated with tetravaccine and exhibiting a febrile reaction G. I. Medvedeva noted considerable change in the motor-evacuatory function of the stomach and intestines. On the basis of experiments involving administration of atropine and transection of the vagus nerves the author concluded that the disturbance of gastric motility which occurs in febrile animals results from an increase in vagal tonus. It may be assumed that the increase in the tonus of Lutken's sphincter in fever is of the same nature.

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All abbreviations of periodicals in the above bibliography are letter-by-letter transliterations of the abbreviations as given in the original Russian journal. *Some or all of this periodical literature may well be available in English translation.* A complete list of the cover-to-cover English translations appears at the back of this issue.
