Acta Medica Okayama

Volume 23, *Issue* 1 1969 *Article* 4

FEBRUARY 1969

Effects of distention of the small intestine on the movements of the gallbladder and the sphincter of Oddi

Sosogu Nakayama*

*Okayama University,

Effects of distention of the small intestine on the movements of the gallbladder and the sphincter of Oddi*

Sosogu Nakayama

Abstract

1. Dogs anesthetized with pentobarbital sodium were mainly used and effects of the distention of the small intestine on the movements of the gall bladder and the sphincter of Oddi were investigated. 2. The distention of the small intestine (jejunum or ileum) inhibited the rhythmic contraction of the gall bladder and duodenal movements, and relaxed the tone of the sphincter of Oddi, resulting in an increase of the outflow of fluid through the orifice of the common bile duct. 3. After cutting the bilateral thoracic splanchnic nerves together with extirpation of the bilateral upper lumbar sympathetic trunks, the inhibitory response on the movements of the gall bladder and the tone of the sphincter of Oddi was completely abolished. The vagus nerve did not take part in the reflex response described above. The transection of the spinal cord at the level between Thl and Th2 produced no change in the reflex responses. 4. Fwm the results described above it may be supposed that effects of the distention of the small intestine on the movements of the gall bladder and the sphincter of Oddi are produced via the thoracic and lumbar splanchnic nerves through the reflex center which is located in the spinal cord.

---

*PMID: 4241734 [PubMed - indexed for MEDLINE]

Acta Med. Okayama **23**, 21—26 (1969)

EFFECTS OF DISTENTION OF THE SMALL INTESTINE ON THE MOVEMENTS OF THE GALL BLADDER AND THE SPHINCTER OF ODDI

Sosogu NAKAYAMA

Department of Physiology, Okayama University Medical School, Okayama, Japan
(Director: Prof. T. Hukuhara)

Received for publication, December 16, 1968

The chemical regulation of the movements of the gall bladder with cholecystokinin has been extensively investigated, while the reflex regulation of it was undertaken only by a few investigators. BIRCH and BOYDEN (1930) (1) observed that electric stimulation on the peritoneal surface of the stomach, small intestine or cecum decreased the tone of the gall bladder and bilateral severance of the splanchnic roots to the celiac ganglia abolished the reflex response. In their experiments, however, the reflex response on the sphincter of Oddi was not examined. Recently WYATT (1967) (3) has reported that the electric or mechanical (pinching with a pair of forceps) stimulation on the stomach and small intestine produced an increase or decrease of the flow of fluid through the sphincter of Oddi.

The present paper deals with the reflex effect in response to distention of the small intestine on the movements of the gall bladder and the tone of the sphincter of Oddi and the reflex pathways.

METHODS

The animals used were twelve dogs anesthetized by intravenous injection of pentobarbital sodium (25 mg/kg). To record the movements of the gall bladder a rubber balloon was inserted through the fundus of the gall bladder and connected with Marey's tambour via a water-manometer. The pressure in the balloon was maintained several centimeters of water. In order to obtain the rhythmic contraction of the gall bladder, two egg yolks were occasionally administered into the duodenal lumen, which was isolated from the stomach and other parts of the small intestine. To investigate change in the tone of the sphincter of Oddi, the common bile duct was perfused through a cannula inserted into the cystic duct through the fundus of the gall bladder, which was connected with Mariotte's bottle filled with Tyrode solution. When the fluid was discharged through the orifice of the common bile duct, the electric drop counter recorded it by an electromagnetic marker on the smoked paper. Simul-

taneously with the discharge of the fluid, the duodenal movements just below the duodenal papilla or the jejunal movements were recorded by means of the balloon-water-manometer system. In order to distend the small intestine, the jejunum or ileum of about 10 cm long was isolated from the other intestine by transection and the loop was distended by an injection of 0.9% saline solution into its lumen by a syringe.

RESULTS

1. *Effects on the movements of the gall bladder.* Several minutes after administration of egg yolks into the duodenum, the rhythmic contractions of the gall bladder usually appeared with a period of 10 to 14 seconds, being accompanied by an increase of its tone. When the jejunum was distended with the pressure of 20 to 30 mm Hg, the rhythmic contractions were abolished and the tone was reduced. Thus the movements of the gall bladder were inhibited (Fig. 1A and B). When the rhythmic contractions occurred relatively powerfully, they were inhibited by the distention under relatively higher pressure and during the distention they reappeared against the inhibitory action (Fig. 2).

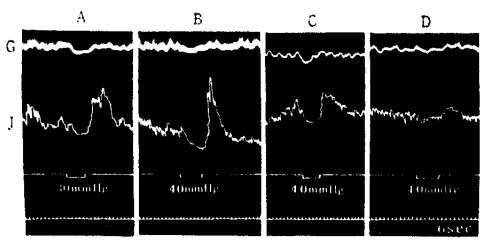

Fig. 1 Effects of distention of the jejunum on the movements of the gall bladder and jejunum. Tracings from above downwards are movements of the gall bladder (G), jejunal movements (J), signal of distention and time in 6 sec. A and B: Control. In C and D, the right and bilateral thoracic splanchnic nerves were cut respectively.

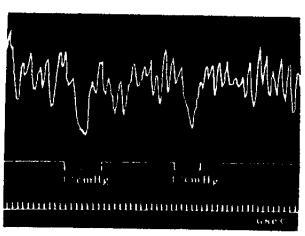

Fig. 2 Effects of distention of the jejunum on the movements of the gall bladder. Tracings from above downwards are movements of the gall bladder, signal of distention of the jejunum and time in 6 sec. Two egg yolks had been previously administered in the duodenal lumen.

Effects of cutting the splanchnic nerves. After cutting the right thoracic splanchnic nerve (the right greater and smaller splanchnic nerves), the distention of the small intestine invariably produced an inhibitory response on the movements of the gall bladder (Fig. 1C), and severance of the bilateral thoracic splanchnic nerves practically abolished the inhbitory response (Fig. 1D), but in a few cases, even after such procedures a slight inhibitory response appeared, while the extirpation of the bilateral upper lumbar sympathetic trunks always abolished it completely (Fig. 3D).

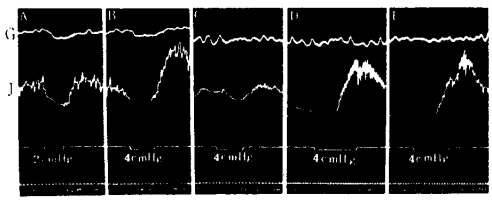

Fig. 3 Effects of distention of the jejunum on the movements of the gall bladder (G) and jejunum (J). A and B: control. C: Bilateral thoracic splanchnic nerves severed. D: Bilateral upper lumbar sympathetic chains were excised in addition. E: The cervical vagus nerves were bilaterally sectioned. Time in 6 sec.

2. *Effects on the sphincter of Oddi.* When the jejunum was distended with the pressure higher than 20 mmHg, the outflow of fluid through the orifice of the common bile duct increased (Fig. 4A) and the duodenal movements just below the duodenal papilla was remarkably inhibited. With increase in the pressure the outflow of fluid increased extremely (Fig. 4B). When the duodenum had no rhythmic movements and was relaxed, the jejunum was distended. Then a remarkable increase in the outflow of fluid appeared (Fig. 5B). It may be presumed that the reflex

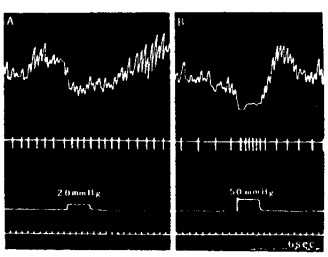

Fig. 4 Effects of distention of the jejunum on the flow of fluid through the orifice of the common bile duct and the duodenal movements. Tracings from above downwards are the duodenal movements, the flow of fluid through the orifice of the common bile duct, signal of distention and time in 6 sec. The same exlpanations are also applicable to the subsequent figure. The pressure of perfusion was consistently maintained at 29 cm H_2O.

relaxation of the sphincter of Oddi produced by the distention of the jejunum resulted in an increase of the outflow of fluid, as will be discussed later in detail. The severance of the bilateral thoracic splanchnic nerves did not abolish the increase in the outflow of fluid and the inhibition of the duodenal movements (Fig. 5C and D), but that of the bilateral lumbar

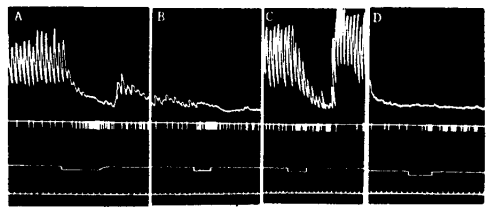

Fig. 5 Effects of distention of the jejunum on the flow of fluid through the orifice of the common bile duct and the duodenal movements. A and B: Control. In C and D, bilateral thoracic splanchnic nerves were severed. In B and D, the movements and tone of the duodenum before distention of the jejunum had been remarkably reduced. From A to C, the pressure of perfusion and the distention of the jejunum were 18 cm H_2O and 45 mmHg respectively. Time in 6 sec.

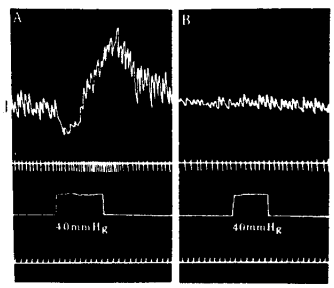

Fig. 6 Effects of distention of the jejunum on the flow of fluid through the orifice of the common bile duct and the jejunal movements (J). In A, bilateral cervical vagus nerves were cut and in B, bilateral thoracic splanchnic and upper lumbar splanchnic nerves were cut off in addition. The pressures of perfusion in A and B were 22 cmH_2O and 26 cmH_2O respectively.

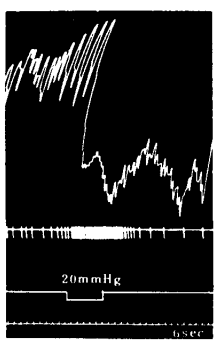

Fig. 7 Effects of distention of the jejunum on the flow of fluid through the orifice of the common bile duct and duodenal movements. Non-anesthetized spinal dog. The pressure of perfusion was 14 cmH_2O.

sympathetic chain abolished both of them completely (Fig. 6B).

Similar responses occurred also in the animal whose spinal cord was transected between Th1 and Th2 (Fig. 7).

3. *Effect of cutting the vagus nerves.* Cutting the bilateral cervical vagus nerves did not change the inhibitory response of the movements of the gall bladder, small intestine and the sphincter of Oddi described above (Fig. 6A).

DISCUSSION

In the present experiment, even after cutting the bilateral vagus nerves distention of the jejunum or ileum inhibited the movements of the gall bladder and the tone of the sphincter of Oddi, and the transection of the spinal cord at the level between Th1 and Th2 produced no change in the reflex responses. On the other hand, cutting of the bilateral thoracic and upper lumbar splanchnic nerves abolished completely the reflex responses. Therefore, it may be considered that the phenomena are elicited through a reflex center which is located in the spinal cord, and that the afferent fibers from the jejunum or ileum and efferent fibers are contained mainly in the thoracic splanchnic nerves and in part in the upper lumbar splanchnic nerves.

Some investigators demonstrated the inhibitory effect of the gall bladder similar to that obtained by the author: DOYON (1894) (2) reported a relaxation of the gall bladder produced by electrical stimulation of the central end of the greater splanchnic nerve and BIRCH and BOYDEN (1930) (1) observed radiographically that electrical stimulation on the peritoneal surface of the stomach, small intestine or cecum diminished the tone of the gall bladder. Recently WYATT (1967) (3) reported that pinching or electrical stimulation of the antrum of the stomach or the duodenum produced an increase or decrease in the tone of the sphincter of Oddi, but the reflex pathways were not examined. Because the sphincter of Oddi is located in the duodenal wall and close to the antrum, it may be supposed that stimulation of these portions elicits both the extrinsic and intrinsic (local) reflexes via the myenteric plexus to the sphincter of Oddi, i. e., the former produces a decrease in tone of the sphincter of Oddi and the latter an increase.

Because the terminal portion of the common bile duct passes obliquely through the duodenal wall, it has been supposed that the relaxation of the duodenal muscle increases the flow of fluid through the orifice of the common bile duct as if the tone of the sphincter of Oddi decreases. But,

even when the duodenal movements hardly take place or the duodenal muscle remarkably relaxes itsself, the distention of the small intestine produces also an increase of the flow of fluid. Consequently, it is presumed that the tone of the sphincter of Oddi is reflexly diminished by distention, thus resulting in the increase of the flow of fluid, and that the activity of the sphincter of Oddi is independent of that of the duodenal muscle, which is located around the terminal part of the common bile duct. Another evidence for the fact will be reported in the subsequent paper.

SUMMARY

1. Dogs anesthetized with pentobarbital sodium were mainly used and effects of the distention of the small intestine on the movements of the gall bladder and the sphincter of Oddi were investigated.

2. The distention of the small intestine (jejunum or ileum) inhibited the rhythmic contraction of the gall bladder and duodenal movements, and relaxed the tone of the sphincter of Oddi, resulting in an increase of the outflow of fluid through the orifice of the common bile duct.

3. After cutting the bilateral thoracic splanchnic nerves together with extirpation of the bilateral upper lumbar sympathetic trunks, the inhibitory response on the movements of the gall bladder and the tone of the sphincter of Oddi was completely abolished. The vagus nerve did not take part in the reflex response described above. The transection of the spinal cord at the level between Th1 and Th2 produced no change in the reflex responses.

4. From the results described above it may be supposed that effects of the distention of the small intestine on the movements of the gall bladder and the sphincter of Oddi are produced via the thoracic and lumbar splanchnic nerves through the reflex center which is located in the spinal cord.

REFERENCES

1. BIRCH, C. L. and BOYDEN, E. A.: Reaction of gall bladder to stimulation of gastrointestinal tract. II. Response to faradic excitation of stomach, small intestine and cecum. *Am. J. Physiol.* **92**, 301—316, 1930
2. DOYON, M.: De l'action excercée par le systéme nerveux. Sur l'appareil excréteur de la bile. *Arch. de Physiol.* **6**, 19—31, 1894
3. WYATT, A. P.: The relationship of the sphincter of Oddi to the stomach, duodenum and gall-bladder. *J. Physiol.* **193**, 225—243, 1967