

# A PHYSIOLOGICAL STUDY ON VOMITING INDUCED BY THE STIMULATION OF THE PARIETAL PERITONEUM OR BILIARY TRACT

by

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(Received for publications : June 20, 1955)

## INTRODUCTION

SCHRAGER and IVY who produced nausea, vomiting and distress by distending the bile ducts and gall bladder in dogs maintained that the afferent paths were the vagi and the right splanchnic nerves.

WALTON, MOORE and GRAHAM had to section both the vagi and the splanchnic nerves in order to prevent vomiting of experimental peritonitis.

WANG and BORISON who studied the afferent paths from the gastrointestinal tract in copper sulphate emesis claimed that the afferent paths were the vagi and the sympathetic nerves.

I studied the afferent paths for vomiting arising from the bile ducts and gall bladder.

On the other hand, vomiting has been considered as a peritoneal symptom by many clinical physicians.

Does vomiting occur by stimulation of the parietal peritoneum?

I attempted to solve this problem. Concerning the sensory innervation of the parietal peritoneum, it will be described in the next report.

## EXPERIMENTAL MATERIALS AND METHODS.

8 young cats (below 1.2kg.) and 18 adult cats (2.0kg-4.0kg) were used.

Experiments were made under following conditions.

- |    |  |         |
|----|--|---------|
| 1) | Unanesthetised, no decerebration, no section of nerve trunks               | 8 cases |
| 2) | decerebration, no section of nerve trunks                                  | 5 cases |
| 3) | decerebration, section of intercostal nerves                               | 2 cases |
| 4) | //    bilateral splanchnectomy   | 3 cases |
| 5) | //    bilateral vagotomy in the neck                                       | 5 cases |
| 6) | //    bilateral vagotomy in the neck together with<br>right splanchnectomy | 3 cases |

Young cats were used only in the first experiments.

Decerebration was performed by SHERINGTON's method.

As indications of noci-reflex I measured the blood pressure through a carotid artery or recorded the contraction of the abdominal rectus muscles by MILLER's method.

Pinching with a forceps was used as a mechanical stimulus on the parietal peritoneum, electric faradization by Du Bois RAYMOND as an electrical stimulus and

painting with tincture of iodine or carbolic acid as a chemical stimulus.

Mechanical and electrical stimuli were given to the biliary tract.

Y. WATANBE of our clinic proved that subcutaneous injection of adequate doses of acetylcholine produced vomiting in cats or it facilitated the emetic response to the mechanical stimulation of the digestive organs. But he did not succeed to produce vomiting after stimulation of the parietal peritoneum by this method.

In my experiments various stimuli were given to the parietal peritoneum or biliary tract after subcutaneous injection of acetylcholine.

Stimuli were given to the vagal branches of the stomach, vagal trunks in the neck and intestine etc. as controls.

### EXPERIMENTAL RESULTS

1. Experiments on the unanesthetized and undecerebrated cats in which nerve trunks were left intact.

8 young cats were used.

The animals were kept in spine position, the abdomen was opened and various stimuli were given on the parietal peritoneum. The animal cried or struggled to avoid, but did not vomit.

Immediately after stimulation of a vagal branch of the stomach it vomited. Soon after vomiting the stimulation were given to the parietal peritoneum but the cat did not vomit.

The abdomen of the animal was opened, a wide area of the parietal peritoneum was painted with tincture of iodine or carbolic acid protecting the abdominal viscera from the chemicals with gauze, and then the abdominal wall was closed. Vomiting did not occur in any case. The following experiments were made in order to decide the sufficient doses of acetylcholine to cause vomiting.

0.2cc, 0.3cc, and 0.4cc of acetylcholine solution (0.1gm/20cc) was subcutaneously injected to each cat 800gm, 860gm, and 760gm in weight respectively. Only the third cat vomited.

The third cat was used on the next day as a experimental material.

760gm ♂ unanesthetised cat was tied in spine position, the abdomen was opened and electrical stimuli were given to the parietal peritoneum, but vomiting did not occur.

It vomited soon after electrical stimulation on the vagal branches of the stomach or the bile ducts.

Immediately after vomiting electric faradization of the parietal peritoneum were made but the animal did not vomit.

Subcutaneous injection of 0.3cc of acetylcholine solution was done to this cat on the day.

In 5 minutes after the administration the animal vomited several times.

In 2 minutes after recovering from vomiting electric faradization was given on the parietal peritoneum (in the ileocecal region)

Vomiting recurred immediately.

2. Experiments on the decerebrated cats.

One of five cats vomited immediately after pinching of the parietal peritoneum (at the navel or in the ileocecal region) with a forceps (Fig. 1). The other four cats vomited easily by stimulating the vagal branches of the stomach or the bile ducts but did not vomit by stimulation of the parietal peritoneum.

Among them, however, the below mentioned 2 cats vomited by electric stimulation of the parietal peritoneum after subcutaneous injection of acetylcholine.

2.8kg. ♀ (Fig. 2)

Electric faradization on a vagal branch of the stomach produced vomiting easily but stimulation of the parietal peritoneum failed to cause vomiting.

In 6 minutes after subcutaneous injection of 0.6cc of acetylcholine solution the animal vomited.

In two minutes after the recovery from vomiting electric faradization were given on the parietal peritoneum at the height of the navel and in the ileocecal region. (2 volt 8cm.)

The animal vomited.

2.2kg ♂ (Fig. 3)

In 5 minutes after subcutaneous injection of 0.5cc of acetylcholine electric faradization was given on the parietal peritoneum in the ileocecal region (2 volt. 8cm) The animal vomited immediately.

3. Experiments on the decerebrated cats in which intercostal nerves were sectioned distal to the white communicant rami.

2.0kg ♂

Right 8th-12th intercostal nerves were sectioned distal to the white communicant rami in the decerebrated cat.

In two minutes after subcutaneous injection of acetylcholine electric faradization was given on the parietal peritoneum in the right upper abdomen. But vomiting did not occur. On the other hand, immediately after electric faradization of the stomach and jejunum the animal vomited. Electric faradization of the parietal peritoneum in the right lower abdomen caused vomiting.

This result suggests that intercostal nerves are the main afferent paths for vomiting arising from the parietal peritoneum in the upper abdomen.

4. Experiments on the decerebrated cats in which bilateral splanchnectomy was done.

The greater and lesser splanchnic nerves were bilaterally sectioned and decerebration was done on the next day.

2.5kg. ♂ (Fig. 4)

Stimulation of vagal braches of the stomach and the bile ducts caused vomiting easily.

Stimulation of the parietal peritoneum did not cause vomiting.

In three minutes after subcutaneous injection of 0.5cc of acetylcholine solution, stimuli were given to the parietal peritoneum in the upper abdomen. But the cat did not vomit.

5. Experiments on the decerebrated cats in which bilateral vagotomy was done

in the neck. 5 cases.

Electric faradization of the bile ducts (the hepatic duct, cystic duct and common bile duct) caused the contraction of the abdominal rectus muscles but did not cause vomiting. (Fig. 5)

Electric faradization of the bile ducts after subcutaneous injection of 0.5cc of acetylcholine solution caused vomiting.

One of the five cats vomited immediately after electric faradization of the parietal peritoneum. (Fig. 6)

6. Experiments on the decerebrated cats in which bilateral vagotomy in the neck and right splanchnectomy were done, 3 cases.

After subcutaneous injection of acetylcholine stimulation of the bile ducts and gall bladder was done. Vomiting did not occur in any case. (Fig. 7)

#### DISCUSSION

Most parts of the parietal peritoneum are afferently innervated by the intercostal and lumbar nerves and a part of the retroperitoneum by the phrenic nerves.

Vagal and splanchnic nerves are not considered to contain afferent nerve fibers from the parietal peritoneum.

The emetic reflex arising from the parietal peritoneum was demonstrated in my experiments.

How can we consider the mechanism of this reflex?

1. The animal vomited by stimulation of the parietal peritoneum under the adequate administration of acetylcholine.

2. A region of the parietal peritoneum which lost the innervation of intercostal nerves gave no emetic response to the stimulations.

3. Bilateral vagotomy did not always inhibit to cause vomiting at the stimulation of the parietal peritoneum.

4. 3 cats in which bilateral splanchnic nerves were sectioned did not vomit by stimulating the parietal peritoneum.

From these results we must consider that the main afferent pathways of emetic reflex from the parietal peritoneum are intercostal nerves and the splanchnic nerves seem to play a role in this reflex as efferent paths as well as the vagal nerves.

The vagus, splanchnic and phrenic nerves are considered to be visceral afferents of the bile ducts or gall bladder.

According to my experiments

1) Stimulation of the bile ducts and gall bladder caused vomiting easily.

2) Stimulation of the bile ducts or gall bladder in bilaterally vagotomized cats couldn't induce vomiting, but the same stimulus given after subcutaneous injection of acetylcholine solution made it possible.

3) Cats in which splanchnic nerves were bilaterally sectioned easily vomited by stimulation on the bile ducts or gall bladder.

#### CONCLUSION

1) Cats rarely vomit by stimulation of the parietal peritoneum without prece-

ding injection of acetylcholine. Vomiting has been considered as a peritoneal symptom by many clinical physicians, but we can not recognize it unless patients are in such a special condition as (acetylcholine) shock.

The afferent paths of this reflex are intercostal nerves and splanchnic nerves seem to play a role in this reflex as efferent paths as well as the vagal nerves.

2) The afferent pathways of emetic reflex from the biliary tract are considered the vagi and the right splanchnic nerves.

I am much indebted to Assist. Prof. Ch. KIMURA, M. D. of our clinic for his constant help throughout my study.

#### Explanation of Figures

**Fig. 1** Pinching the parietal peritoneum with a forceps caused vomiting. Kymogram shows the contraction of abd. rectus muscles on both sides.

**Fig. 2** Electric faradization of parietal peritoneum (at the navel) after subcutaneous injection of A. C. H. caused vomiting. Kymogram shows the change of the blood pressure.

**Fig. 3** Electric faradization of the parietal peritoneum after subcutaneous injection caused vomiting. Kymogram shows the contraction of abd. rectus muscle.

**Fig. 4** Bilateral splanchnectomy. Electric faradization of the parietal peritoneum did not cause vomiting even after subcutaneous injection of A. C. H. Kymogram shows blood pressure during the experiment.

**Fig. 5** Bilateral vagotomy in the neck. Stimulation of the biliary tract did not cause vomiting. The contraction of the abdominal rectus muscles.

**Fig. 6** Bilateral vagotomy in the neck. Stimulation of the parietal peritoneum after subcutaneous injection of A. C. H. caused vomiting. Kymogram shows the contraction of abd. rectus muscle.

**Fig. 7** Bilateral vagotomy in the neck, Right splanchnectomy. Electric faradization of the biliary tract caused the rise in the blood pressure but no vomiting even after subcutaneous injection of A.C. H.

#### References

- 1) Asai, S., and Masuyama, M., Kyoto Igaku Zassi **25**, 31, 1928
- 2) Cannon, B., Am. J. Physiol. **105**, 366, 1933
- 3) Derbyshire A., and Ferguson, J., Am. J. Physiol. **123**, 52, 1937
- 4) Goldberg, S. L., Am. J. Physiol. **99**, 156, 1931
- 5) Hatcher, R. A., Physiological Reviews **4**, 479, 1924
- 6) Hacher, R. A., and Weiss, J. Pharm. Exp. Therap. **22**, 139, 1924
- 7) Kimura, Ch., Nihon Gekagakukai Zassi **52**, 450, 1951
- 8) Kimura, Ch., Rinsho no Shinpo **7**
- 9) Kushizaki, K. Nihon Yakurigaku Zassi **42**, 148,
- 10) Kunz, A., The Autonomic Nervous System **239**, 256, 1947
- 11) Kure, K., and Okinaka S., Jiritsu Shin-

- keikei 1941
- 12) Miller, F. R., J. Physiol. **41**, 409, 1910
- 13) Miller, F. R., Am. J. Physiol. **71**, 84, 1924
- 14) Miller, F. R., and Simpson H. M., Am. J. Physiol. **72**, 231, 1925
- 15) Openshowski, T., Zentral. f. Phys. **3**, 1, 1889-1890
- 16) Schragar, R. L., and Ivy, A. C., Surg, Gynec, and Obst. **54**, 133, 1932
- 17) Sherrington, C. S., J. Physiol. **38**, 375, 1909
- 18) Wangs. C., and Borison, H. L., Am. J. Physiol, **164**, 520, 1951
- 19) Watanabe, Y., Archiv für japanische Chirurgie **23**, 38 1954
- 20) White, J. C., and Smithwick, R. H., The Autonomic Nervous System 1941.

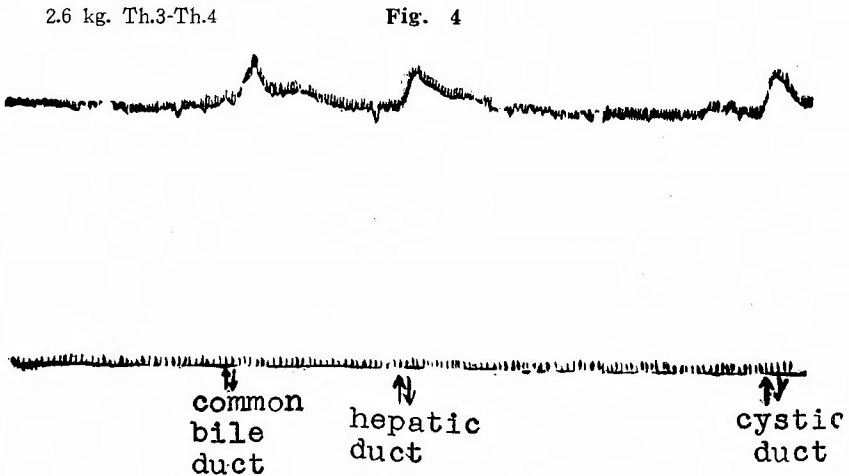
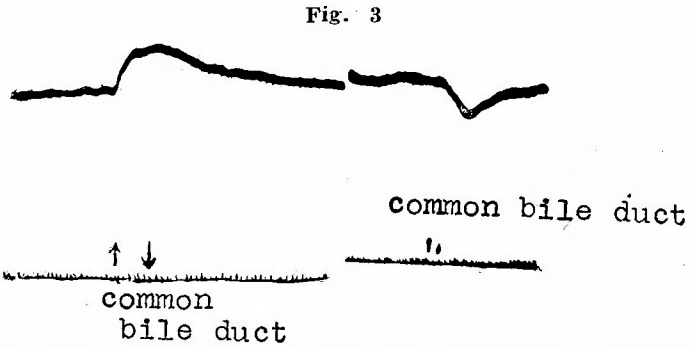
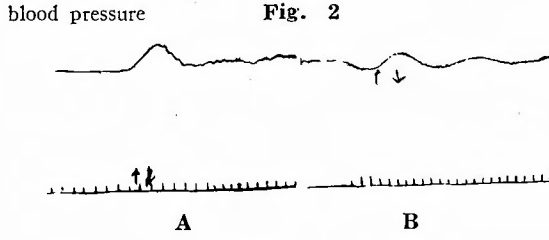
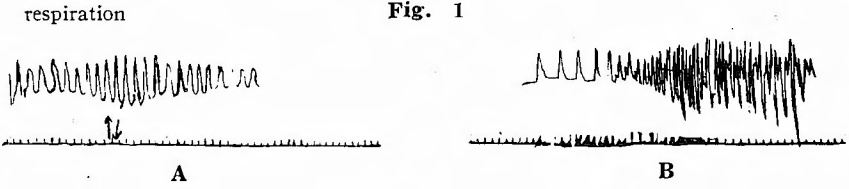
和文抄録

## 体壁腹膜或は胆道の刺戟により惹起される 嘔吐に関する生理学的研究

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多くの臨床家により腹膜刺戟症状と考えられている嘔吐が果して体壁腹膜の刺戟に依つて起り得るもの



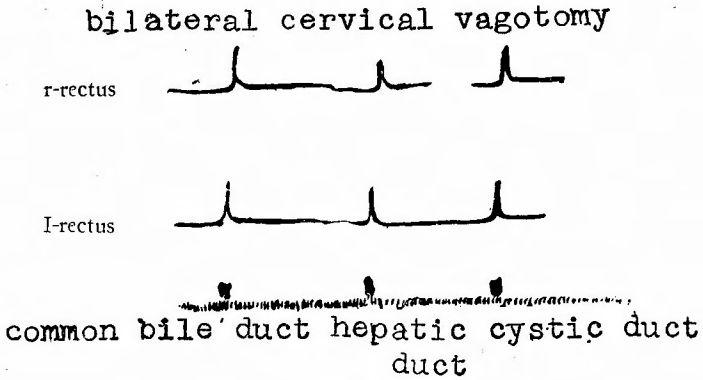


Fig. 5

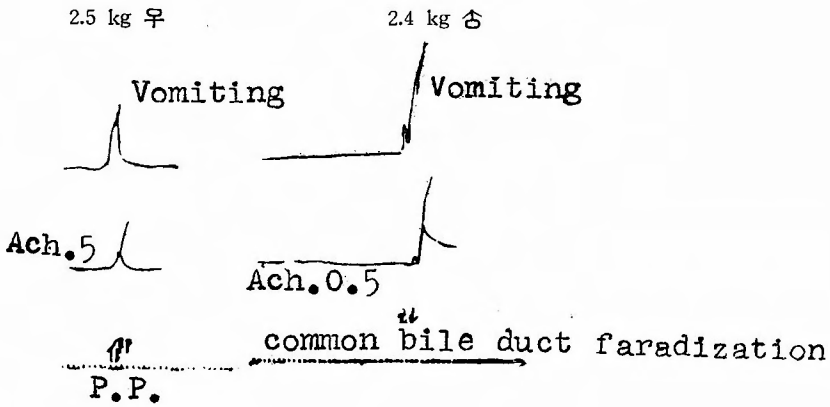


Fig. 6

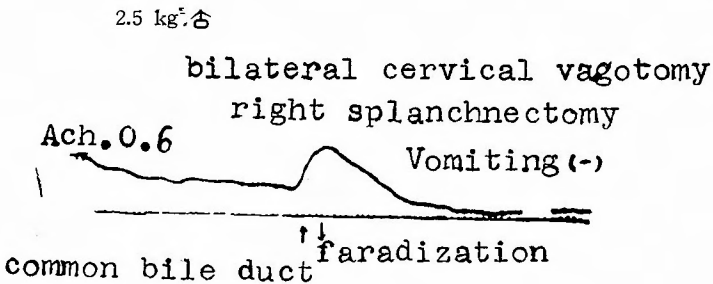


Fig. 7

であるか、猫を使用して、此の問題に実験的吟味を加え、又胆道の刺戟により惹起される嘔吐の求心路を研究した。

1) 予めアセチルコリンを注射して嘔吐を誘発せしめ、その恢復後2~3分後体壁腹膜を刺戟すれば、嘔吐を再発せしめ得る。

予めアセチルコリンの注射をしない場合、体壁腹膜の刺戟により、猫に嘔吐を誘起することは出来ない。これにより、嘔吐は多くの臨床家により腹膜刺戟

症状と考えられているが、患者がショックのような特殊の条件に置かれなければ、このような症状は発現し難いと考えられる。

この反射の求心路は肋間神経で、内臓神経はこの反射に於いて迷走神経と同様に、遠心路としてある役割を果たすものの如くである。

2) 胆道からの嘔吐反射の求心路は、迷走神経と右内臓神経と考えられる。