THE AFFERENT PATHS OF NERVES INVOLVED IN THE VOMITING REFLEX INDUCED BY DISTENTION OF AN ISOLATED PYLORIC POUCH

SAMUEL L. GOLDBERG

From the Division of Experimental Surgery and Pathology, The Mayo Foundation, Rochester, Minnesota

Received for publication August 3, 1931

That the sensory fibers involved in the vomiting reflex arc follow pathways of the autonomic nervous system is not accepted by all investigators. In the progress of experimental work that involved injecting solutions into isolated pyloric pouches of dogs, an opportunity presented itself to study this problem.

It was found that distention of pyloric pouches until the pressure within the pouch reached a definite level invariably induced vomiting. The pouches were prepared by a modified two-stage Polya resection type of operation, which involved complete section of the wall of the stomach through the so-called prepyloric and the pyloric sphincters. Ivy and Oyama (1921), and Lim and Dott (1922) consider that such pouches are denervated of vagus fibers. As the vomiting was invariable, it appeared that either the afferent fibers passed over the pathways of the sympathetic nerves, or that the supposedly denervated pouches contained vagus fibers.

In the past, the autonomic nervous system was believed to be entirely made up of efferent fibers. Gaskell's view that the sympathetic system is made up of two elements, one of which is motor cells that have migrated from the central nervous system, and the other, their communicating fibers, is well known. The sympathetic system does not contain afferent fibers, and all reflex arcs involving this network have fibers of the central nervous system on the afferent side.

Langley (1903) stated his belief that all nonmedullated fibers are efferent and that the sympathetic system is not complete but consists purely of excitor neurones. Langley and Anderson concluded that the two supposed examples of sympathetic reflex arcs, namely, the salivary reflex through the submaxillary ganglion and the vesical reflex through the inferior mesenteric ganglion, are so-called axon reflexes and not true reflex arcs.

Miller (1911) studying the pathways involved in the emetic action of mustard, reached the conclusion that the vagus nerve is the only afferent pathway, as vagotomy definitely inhibited that action. Tilney and Riley...
expressed the belief that the vagus and glossopharyngeal nerves are the afferent pathways of vomiting reflexes.

Ranson (1918) stated that satisfactory evidence is lacking of afferent neurones having their cell bodies in the sympathetic system, and that all visceral reflex arcs must pass through the central nervous system, except local myenteric reflexes within the wall of the intestine.

Lewandowski (1919) was probably the first investigator to imply that the autonomic system included afferent fibers from the viscera. These, if they existed, might be the afferent fibers in vomiting reflexes.

Hatcher and Weiss (1922), following the work of Hatcher and Eggleston (1912) who proved that the emetic action of the digitalis bodies is central, believed that reflex nausea and vomiting caused by these bodies is through direct action on the heart, stimulating afferent fibers in that organ which pass along the pathways of the sympathetic nerves, but also pass in part by the vagus nerve to the medullary vomiting center. This belief was based on the results of the actions of drugs in acute experiments, and as such are not fully accepted by all investigators. Alvarez (1928) accepted fibers passing along the autonomic system as being afferent fibers in the reflex arc.

Methods and results. When it had been definitely established that distention of four of these pyloric pouches invariably produced vomiting, the pressure within the pouch necessary to initiate the reflex was measured by a T apparatus. One arm of the crosspiece was connected to a retention catheter in the pouch, the other to a mercury manometer, and the remaining portion of the T was used as the water supply to the system. It was found that a pressure of from 30 to 35 mm. of mercury was necessary to initiate the reflex. This remained remarkably constant, regardless of the solution used. Water, dilute acids, alkalis and mustard were used.

Vagotomy was done on three of the four dogs by the transpleural approach through an incision made in either the seventh or eighth intercostal space as suggested by Beaver and Mann. These and other operative procedures were carried out under ether anesthesia, and sterile technic. A section of the right vagus nerve several centimeters long was resected to preclude regeneration, the mediastinum was broken posteriorly, and the left vagus nerve was similarly resected.

Two of the three dogs so prepared could no longer be induced to vomit by distention of the pouch, although pressure within the pouch was raised to about twice that which invariably induced emesis before vagotomy. Distention of the pouch of the third dog continued to induce vomiting. The right sympathetic chain was evulsed from this dog, using a transpleural approach, from a point just below the diaphragm to well up into the thorax, six rami being removed. This procedure had no effect on the vomiting reflex. Similarly, removal of the same length of the left sympa-
thetic chain did not have any effect on the reflex. It was suggested that
there might be some fibers in the right phrenic nerve which were acting as
afficients to the arc, and right phrenicectomy was done in the neck, but the
status of the reflex did not change.

At this stage it was believed that possibly a branch of the vagus nerve
had been left intact during vagotomy, and the vagi were explored through
the old right intercostal incision. It was found that the left vagus had
split into two branches at a point higher than usual, and that only one
branch had been resected. The other branch was resected, following which
vomiting could no longer be induced by distention of the pouch. A splen-
did control had been inadvertently established through a fortunate error
in technic. In all the experiments, therefore, vagotomy prevented the
invariable reflex of vomiting, as produced by distention of a pyloric pouch.

Pouches of the fundus of the stomach were distended many times in
unsuccessful attempts to induce emesis, as were pouches of the pylorus and
fundus that had been transplanted into the subcutaneous tissue after the
method of Ivy and Farrell (1925). It is not to be expected that vomiting
could be induced by distending these pouches, as they are truly denervated,
and there is no evidence at present that vomiting can be induced through
a humeral mechanism.

COMMENT. In the light of the views of various observers it is not sur-
prising to find that the afferent arc in this particular vomiting reflex is
purely through the vagus. The work of Hatcher and Weiss (1922) is the
basis of the idea that the fibers of the autonomic system may act as affer-
ents in this arc. In their experiments the heart is the site of the stimulus,
and it is possible that afferent impulses may leave this organ along tracts
of the sympathetic nerve fibers. Evidence is not available to support the
idea that a stimulus arising within the gastro-intestinal tract can induce
vomiting by producing sensations that pass along autonomic nerve fibers.

It is interesting to note that the pouches which were supposedly free of
intact fibers of the vagus actually were not completely denervated. Un-
doubtedly a good proportion of these fibers have been severed, but enough
remained for the purpose of setting up at least this reflex arc when stimu-
lated. What effect this may have on experimental work with secretion
or pyloric pouches so prepared is problematic.

Why distention of the antrum of the stomach will induce vomiting,
whereas distention of the fundus will not, is as yet unsolved. The fibers
of the vagus probably enter the pouches by either or both of two paths
with the sympathetic nerves along blood vessels, or with a branch of the
vagus from the liver to the pylorus. Bayliss and Starling (1899) have
shown that the vagus gives a branch to the solar plexus, and it is possible
that some of these fibers are distributed to the wall of the stomach along
with the nonmedullated fibers. Whether these fibers do not reach the
fundus, or whether the branch of the vagus from the liver carries all the 
impulses from the antrum which induce emesis has not been determined. 
The significance of distention of the antrum as a mechanism of inducing 
vomiting is also unknown. It would seem that it would be one of the most 
physiologic stimuli acting on the intact stomach, but there is no evidence 
that it is a more important stimulus to vomiting than any other stimulus 
that arises in other organs, or that is induced either directly or indirectly 
by the actions of drugs and other substances on the vomiting center.

SUMMARY

Reflex vomiting can be induced by distending an isolated pyloric pouch 
until the pressure within the pouch rises above a certain constant level 
which can be definitely measured.

The afferent side of this reflex arc is entirely through the vagus nerves. 
Supposedly denervated pouches contain enough intact vagus fibers to 
carry these afferent impulses.

BIBLIOGRAPHY

ALVAREZ, W. C. 1928. The mechanics of the digestive tract. New York, Paul 


BEAVER, M. G. AND F. C. MANN. 1931. Technic for opening and closing the chest 
in experimental surgery (in press).


IVY, A. C. AND J. I. FARRELL. 1925. This Journal, lxiv, 630.

IVY, A. C. AND Y. OYAMA. 1921. This Journal, lvii, 51.


TILNEY, F. AND H. A. RILEY. 1921. The form and functions of the central nervous 