

## AN EXPERIMENTAL STUDY OF ANTIPERISTALTIC JEJUNAL LOOPS\*

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SINCE THE FIRST REPORT in 1935 by Whipple, Parsons and Mullins<sup>15</sup> of a radical resection of the duodenum and head of the pancreas for carcinoma of the ampulla of Vater, numerous modifications have been tried to overcome the difficulties which followed the initial procedure. The important complication of cholangitis led Whipple<sup>16</sup> in 1938 to anastomose the gallbladder, and later the common bile duct, to an antiperistaltic limb of jejunum created by the Roux-Y type of anastomosis. The same type of anastomosis has been used by Allen,<sup>1</sup> Cole<sup>3</sup> and others for the correction of impermeable strictures of the common bile duct.

The distressing complication of cholangitis occurs even after the modified Whipple procedure has been used, and this has stimulated interest as to the mechanism. The organism most commonly mentioned as being responsible was the colon bacillus. Numerous mechanical causes have been proposed. Wangenstein<sup>14</sup> stressed the importance of a non-patent or stenosed stoma as an important factor in the production of cholangitis following cholecystenterostomy. Very little information is available, however, on the best length of the antiperistaltic segment of bowel to be used in the Roux-Y type of anastomosis. In reviewing the many modifications of the original Whipple operation, the authors could find only the following references to the length of antiperistaltic limb of jejunum utilized. Pearse<sup>12</sup> initially used a six inch loop. In later cases, this was lengthened. Dennis<sup>5</sup> stated that 40 centimeters of jejunal segment were used to separate the biliary from the gastric anastomosis. His patients did not experience any postoperative cholangitis, and postoperative fluoroscopy on one of his patients "showed rapid emptying of the gastric pouch with no regurgitation into the proximal jejunal loop." Cole<sup>3</sup> stated that the antiperistaltic limb should be at least 24 inches long when utilized in common duct surgery.

Hence, it was felt that an attempt should be made to determine the optimum length of an antiperistaltic limb of bowel. Also, that a comparison should be established between antiperistaltic limbs of jejunum and loops of jejunum "dysfunctional" by an enteroenterostomy as suggested by Cattell,<sup>2</sup> Cole<sup>3</sup> and others.

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## METHODS

In order to determine the extent of regurgitation in an antiperistaltic limb of small bowel, the following experiments were performed on dogs. In the first phase of the experiment, a jejunal fistula was utilized using the method of Mann and Bollman.<sup>8</sup> The abdomen was opened; the ligament of Treitz identified and divided. Approximately six inches beyond the ligament, the proximal jejunum was divided and the distal end brought out through a stab wound in the abdominal wall as a permanent stoma. A Roux-Y type of enteroenterostomy was performed implanting the proximal end of the transected jejunum into the antimesenteric border of the distal end at distances of four, eight, ten, 12, 14, 16, 20 and 24 inches from the stoma. (Fig. 1.) Postoperatively all dogs were watched carefully for the loss of

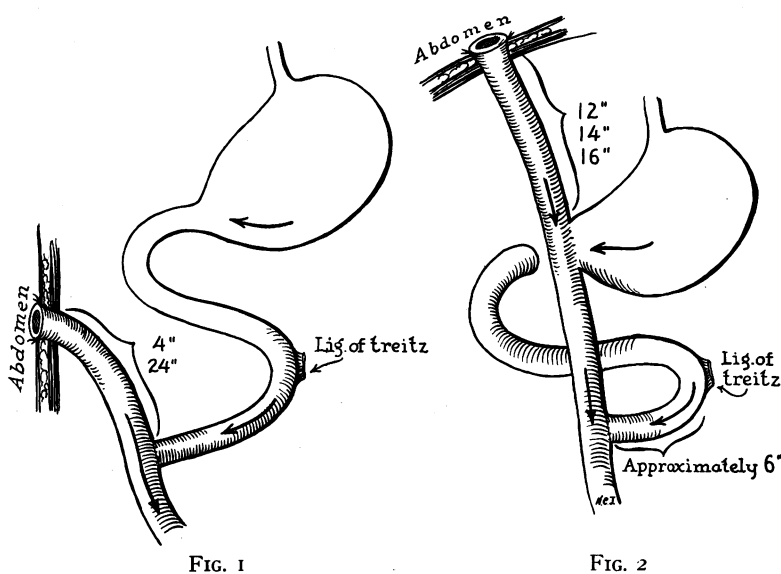


FIG. 1.—Jejunojunal fistula.  
FIG. 2.—Gastrojejunal fistula.

intestinal secretions through the stoma. Dye, in the form of methylene blue 0.24 Gm., was given orally and staining of the stoma recorded. In addition, some dogs were studied fluoroscopically following the administration of barium by gavage without sedation or anaesthesia.

In the second phase of the experiment, the abdomen was opened and the ligament of Treitz identified and cut. Approximately six inches beyond the ligament, the jejunum was divided, and following resection of the pyloric ring of the stomach and closure of the proximal duodenum, the distal end of the transected jejunum was brought out through a stab wound in the abdominal wall as a permanent stoma. An end-to-side gastrojejunostomy was performed,

thus creating above the gastric anastomosis antiperistaltic limbs of jejunum of 12, 14, and 16 inch lengths. The proximal end of the transected jejunum was reimplanted into the distal segment approximately six inches below the gastric anastomosis. Figure 2 which illustrates the second procedure closely simulates that seen in Whipple's article of June, 1946<sup>18</sup> "showing antecolic or postcolic anastomoses with an antiperistaltic limb of resected jejunum." In our experiments no biliary anastomoses were performed, nor were the pancreas and duodenum extirpated.

In the third phase of the experiment, the abdomen was opened and the ligament of Treitz identified. Approximately eight inches from the ligament an enteroenterostomy was performed, the stomata being eight centimeters in length, creating "defunctioned" loops 24, 32, and 48 inches in length. The mid point of the loops was brought out through the incision and sutured to the wall. After closing the incision, an opening was made in the bowel wall creating a permanent stoma as illustrated in Figure 3.

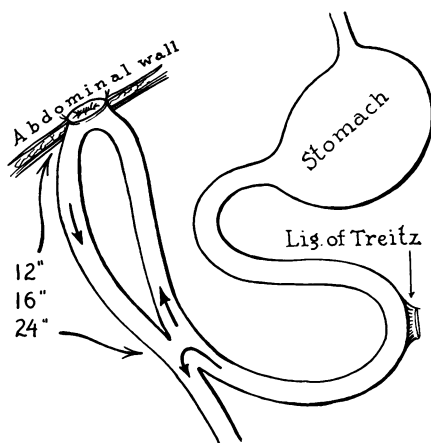


FIG. 3.—Fistula of jejunal loop "defunctioned" by a jejunojejunostomy.

#### DISCUSSION

Table I summarizes the first group of experiments where variable lengths of antiperistaltic jejunal fistulae were used. It is noted that in addition to a dye given orally, the material constituting the intestinal stream will regurgitate up an antiperistaltic limb ten inches in length. Fluoroscopically, following the introduction of barium by gavage, the barium was not seen to traverse an antiperistaltic limb eight inches in length, but 15 minutes later appeared at the stoma. Observations of limbs 12 and 14 inches in length showed the barium to enter the limb readily for a distance of six inches. Postmortem examination of all of these dogs failed to reveal the presence of ulcerations in the mucosa about the stomal sites.

Table II summarizes the results in the second group of experiments where gastrojejunal antiperistaltic limbs were utilized. The minimum length of limb used was 12 inches on the basis of the previous experiment. Because of the more forceful evacuatory contractions of the stomach, it was surmised that a limb 12 inches in length would be too short. However, as noted, neither dye nor intestinal juices appeared at the stoma of a 12, 14 or 16 inch limb. Fluoroscopically, the barium entered both 12 inch limbs for a distance of five to six inches. (Fig. 4.) In one instance, the barium disappeared from the limb with the appearance of peristaltic waves. However, in the other case,

the barium persisted as a thin line despite vigorous contraction waves down the limb. Postmortem examination revealed the presence of ulcers in the 14 and 16 inch limbs in the jejunum just opposite the gastrojejuno-stoma (Fig. 5-Fig. 6) when sacrificed 50 days and 45 days postoperatively, respectively. This closely simulates the work and findings of Mann and Williamson<sup>9</sup> in one phase of their classical experiments on the production of peptic ulcers.

TABLE I.—*Antiperistaltic Jejunojunal Fistulae*

Dog Number	Length of Antiperistaltic Limb	Presence of Intestinal Juices	Presence of Dye	Remarks
47-62	4"	Profuse brownish green in 6th postoperative day	None seen	Dog died 10 postoperative day of peritonitis.
47-65	8"	Questionable	None given	Dog sacrificed on 5th postoperative day because of distemper.
47-77	8"	Small amount of intestinal juice on 6th postoperative day	None given	Dog died on 6th postoperative day. Perforation at suture line.
47-83	8"	Scant fecal material noted	None	Given barium p. o. and fluoroscoped. 15 minutes later barium appeared at stoma. Loop lengthened to 24".
47-204	10"	Some gas and scant fecal material	Yes	Dog sacrificed 2 weeks p. o. Did poorly. Chronic bilateral glomerulonephritis and nephrosis.
47-222	10"	Slight on 6th p. o. day	None	
41-50	12"	None	None	
Short, black female cocker	12"	None	None	On fluoroscopy, barium readily entered antiperistaltic limb for distance 6". None at stoma.
47-162	14"	None	None	
40-34	16"	None	None	
41-53	20"	None	None	
47-83	24"	None	None	

Table III summarizes the results of the third group of experiments where loops of jejunum were utilized which had been "defunctioned" by means of an enteroenterostomy. Loops with 12-inch limbs were much too short. Despite a wide, patent enterostomy stoma, all of these dogs died within eight days from the time of operation. Dye and intestinal secretions literally poured out of the stomata. The deaths may be attributed to loss of fluids and electrolytes from a high fistula similar to that of a high intestinal obstruction.<sup>10</sup> The loop with a 16 inch limb was still too short to prevent loss of intestinal juices. The loop

ANTIPERISTALTIC JEJUNAL LOOPS

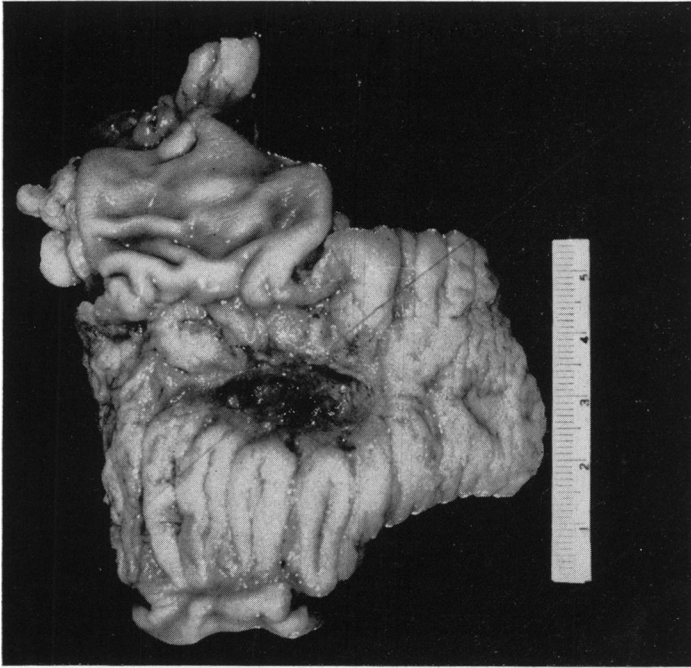


FIG. 5.—Ulcer on posterior wall of jejunum opposite the  
gastricostomy stoma

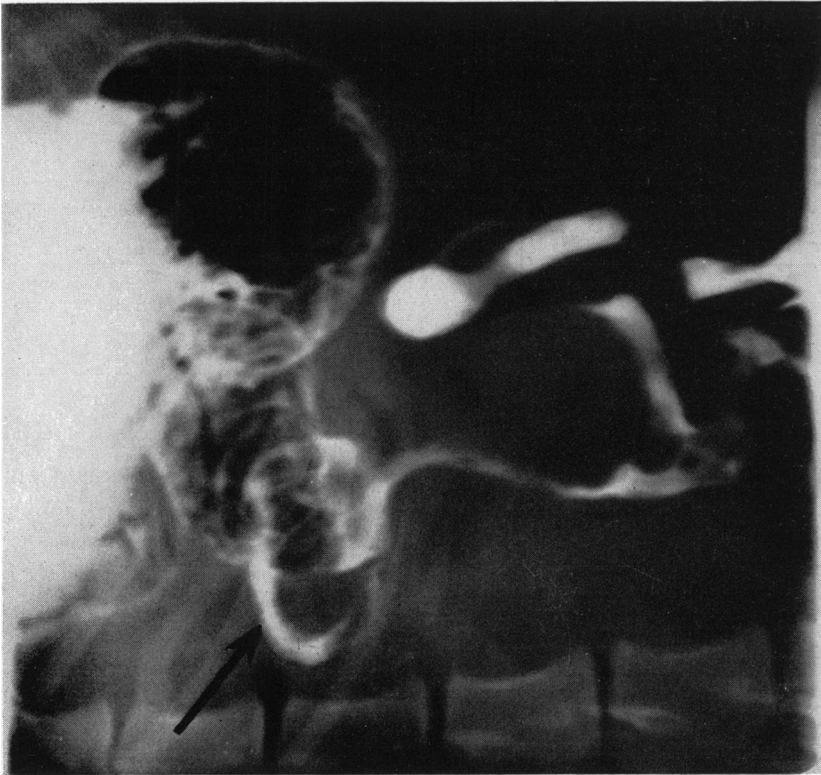


FIG. 4.—Arrow designates anti-peristaltic limb of jejunum containing barium.

with a 24-inch limb, although it prolonged the dog's life, was unsuccessful in completely diverting the intestinal stream.

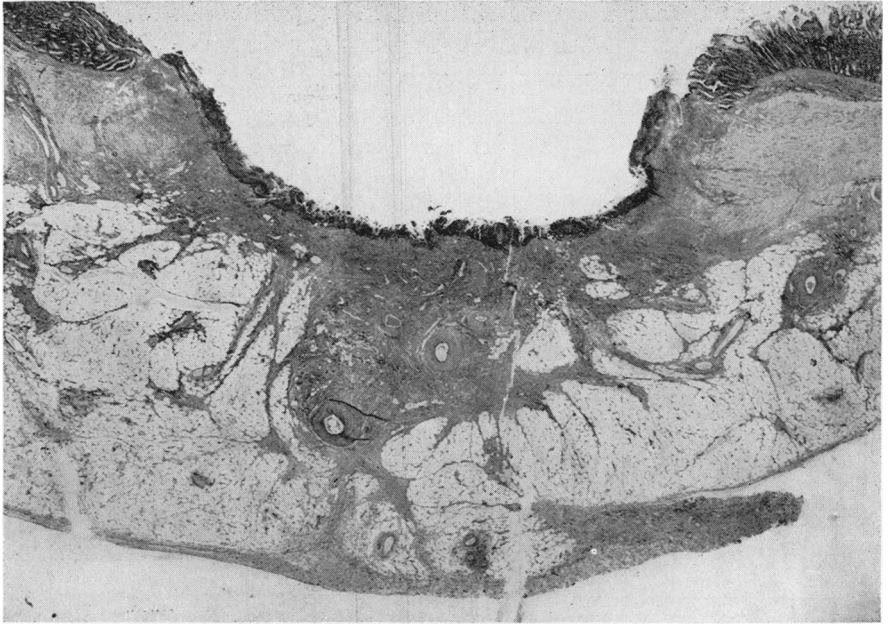


FIG. 6.—Photomicrograph of ulcer of Fig. 5. x12.5

TABLE II.—*Antiperistaltic Gastrojejunal Fistulae*

Dog Number	Length of Antiperistaltic Limb	Presence of Intestinal Juice	Presence of Dye	Remarks
48-27	12"	None	None	Fluoroscopically showed regurgitation into antiperistaltic segment for 4-5 inches. Sacrificed 78 days p. o. No ulcers noted.
48-63	12"	None	None	Barium entered limb readily for 4 inches. Sacrificed 56 days p. o. No ulcers noted.
48-5	14"			Dog died 2nd p. o. day. Acute dilatation of stomach.
47-235	14"	None	None	At post mortem ulcer noted on posterior wall of jejunum opposite gastrojejunal stoma. (50 days p. o.)
47-164	16"	None	None	Ulcer noted same as above. (45 days p. o.)

#### CONCLUSIONS

1. In dogs regurgitation occurred for a distance of ten inches in an antiperistaltic limb of jejunum created by a Roux-Y type of anastomosis.
2. The optimum length for the antiperistaltic limb of a Roux-Y type of

anastomosis was found to be 12 inches. This prevented regurgitation of dye, barium or intestinal contents out of the stoma.

3. No difference was noted in the extent of regurgitation in an anti-peristaltic limb created by a jejunojejunostomy or a gastrojejunostomy. Hence, the important factor was the length of the limb, and the force with which material entered the loop was apparently of lesser significance.

TABLE III.—“Defunctioned” Jejunal Loop Fistulae

Dog Number	Length of Ascending Limb of Loop	Presence of Intestinal Juice	Presence of Dye	Remarks
47-172	12"	Profuse	Yes	Died 7 p. o. day.
48-10	12"	Profuse	Yes	Died 8 p. o. day.
48-14	12"	Profuse	Yes	Died 7 p. o. day.
47-209	16"	Some discharge daily from stoma	Yes	Alive at end of 18th p. o. day. Sacrificed. Dye given day previously stained entire ascending loop.
48-34	24"	Slight discharge	Slight staining	

4. The use of loops longer than 12 inches in a gastrojejunal Roux-Y anastomosis resulted in peptic ulcer formation.

5. An enteroenterostomy between loops of jejunum does not short-circuit these loops. The enteroenterostomy does not divert all of the intestinal stream even when the limbs of the loops are 24 inches in length.

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