

II. Length of Afferent Duodenojejunal Loop in Gastric Resection, a Factor in Stomal Ulcer.*

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A high incidence of gastrojejunal ulcer has been reported from some clinics even after extensive gastric resection. The experience of this clinic with gastric resection for ulcer would suggest that the so-called intractable or incurable ulcer is a myth and that, if the criteria of a suitable operation for ulcer are satisfactorily met, recurrent ulcer will not follow. In this study, it is proposed to evaluate the importance, if any, of the length of the afferent duodenojejunal loop in protecting against stomal ulcer following extensive gastric resection in dogs.

Methods and Results. This group of experiments was carried out on 22 dogs in 3 series. An extensive gastric resection, carried out on the Billroth II plan of operation, was performed in each animal in the 3 series of experiments. The length of the afferent duodenal loop was short in Series I. In Series II and III the afferent duodenojejunal loop was long. Histamine in beeswax was administered to the dogs in Series I and II.

The operative procedure was accomplished in the following manner. The dog was anesthetized by means of intra-tracheal ether or intravenous nembutal, 15 mg per pound. Under aseptic conditions a laparotomy was performed. The duodenum was transected immediately distal to the pyloric sphincter. The duodenal end then was inverted. An extensive resection of the stomach was carried out, approximately 75% of the distal portion of the stomach being excised. The Hofmeister procedure was performed on the lesser curvature side. Gastro-intestinal continuity

was completed by means of an end-to-side gastrojejunostomy. The abdomen was closed and the animal removed to his cage. Interrupted cotton sutures were used throughout.

During the early convalescent period, water and food were withheld. Parenteral 10% glucose was administered daily in distilled water or saline solution as indicated. After 48 to 72 hr, water and food by mouth were allowed. By the 10th postoperative day, the regular daily diet consisting of dog kibble, horsemeat and table scraps had been resumed on regular feeding schedules.

Series I. Eleven dogs were used. These dogs were subjected to an extensive gastric resection (75%). The gastrojejunostomy was performed as close to the inverted duodenal end as was technically feasible, the distance from the blind duodenal end varying from 12 to 15 cm. After this operative procedure, 3 months were allowed to elapse. Then 30 mg histamine base in beeswax, prepared after the method of Code and Varco¹ was injected intramuscularly each day. The injection was made into the back muscles at multiple sites in order to allow uniform absorption. Injections were made at 5 P. M. daily, following which food pans were removed. Water was allowed throughout the night. Feeding was reinstituted early the following morning. A total of 40 to 45 injections was carried out on each animal. There were no deaths. The animals were sacrificed after the last injection. The results are tabulated in Table I.

In spite of severe histamine stimulation, not one gastrojejunal ulcer was encountered. This is significant. (Table I).

Series II. The identical operation described above was performed, (extensive gastric resec-

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¹ Code, C. F., and Vareo, R. L., *Proc. Soc. Exp. Biol. and Med.*, 1940, **44**, 475.

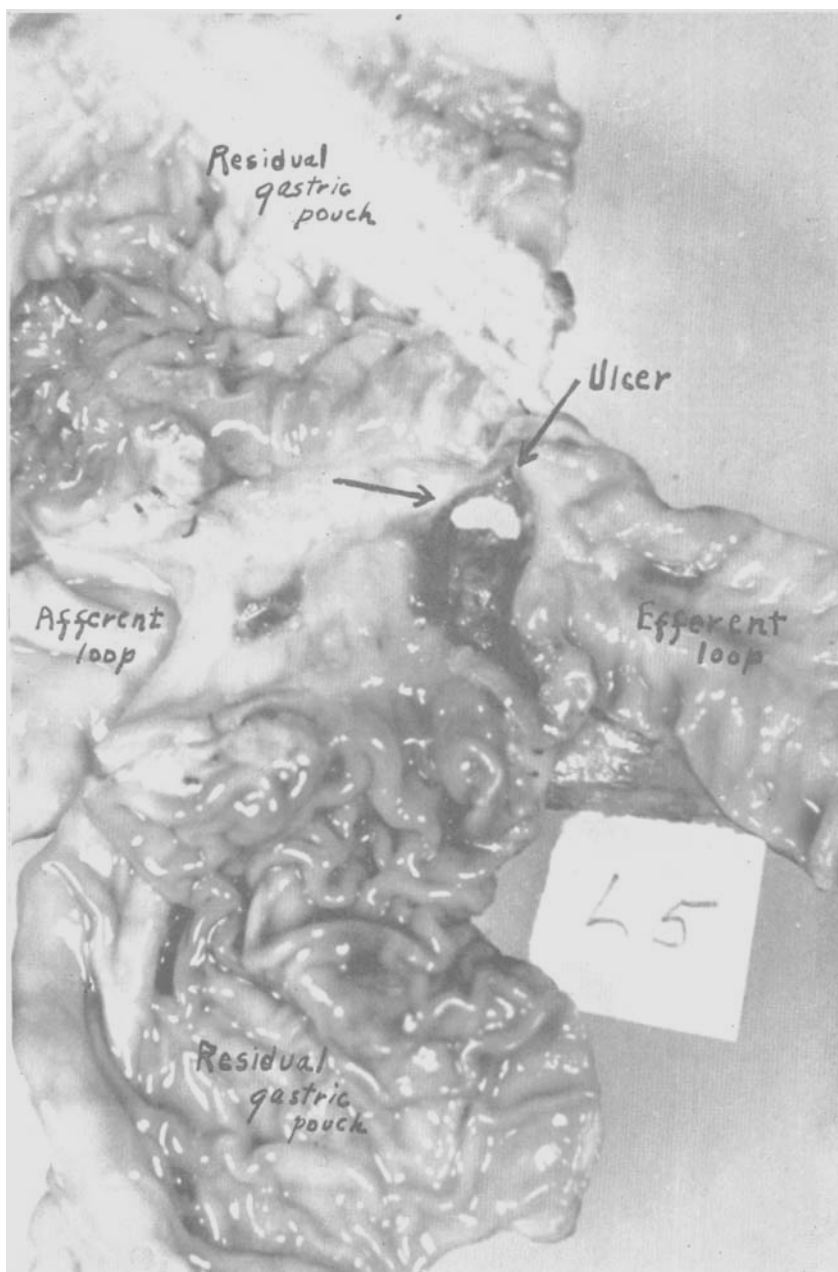


FIG. 1.

Photograph of perforated gastrojejunal ulcer occurring after extensive gastric resection (75%). The afferent duodenojejunal loop was 78 cm in length. Death occurred 12 days after the administration of histamine was commenced.

tion—75%) with one difference. In these animals, a longer afferent duodenojejunal loop was employed. The distance from the inverted duodenal end to the site of gastrojejunostomy varied from 27 to 78 cm. Similarly, a rest

period of 3 months was allowed to intervene. Following this, 30 mg of histamine base in beeswax was injected intramuscularly daily. The results obtained are recorded in Table II.

In this series, gastrojejunal ulcer was ob-

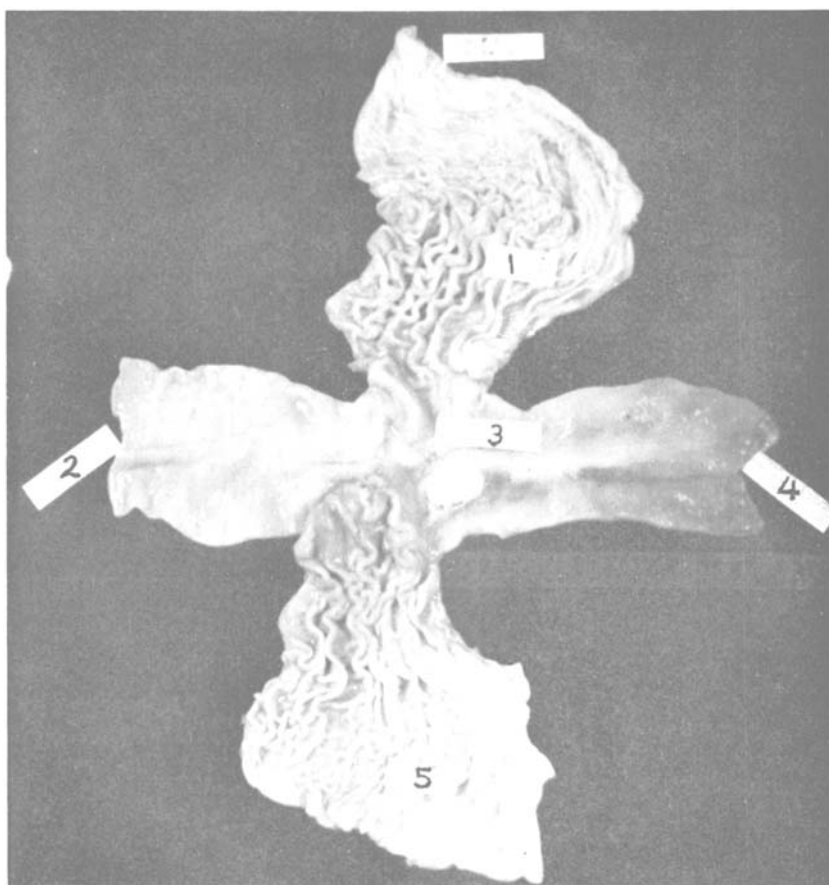


FIG. 2.

Spontaneous gastrojejunal ulcer occurring after a 50% gastric resection accompanied by a long afferent duodenojejunal loop. 1, stomach; 2, efferent loop; 3, jejunal ulcer; 4, afferent loop; 5, stomach.

served in each instance (100%). These results are in striking contrast to the results in Series I. Three of the 7 dogs in Series II died of generalized peritonitis attending perforation of a stomal ulcer. Dogs No. 4 and 5 had the longest afferent duodenojejunal loops. Both these dogs died of perforated gastrojejunal ulcer. Their survival periods were the shortest of the entire series. This occurrence suggests that a long afferent loop invites early formation of a gastrojejunal ulcer.

Series III. In a group of 4 dogs, gastric resection was done, varying in extent from 50 to 75%. The length of the afferent duodenojejunal loop in these 4 experiments varied between 78 and 144 cm. These dogs received no histamine. Two of the 4 dogs died of

spontaneous perforation of a gastrojejunal ulcer located just beyond the efferent outlet. One dog, in which a 50% gastric excision had been done accompanied by an efferent duodenojejunal loop of 78 cm, was sacrificed 210 days after operation. There was no stomal ulcer. One other dog is still alive and apparently well more than 2 years after operation.

Summary. The results of these experiments are striking. In 11 dogs (Series I), with an extensive gastric resection (75%), in which the afferent duodenal loop was short (12 to 15 cm) stomal ulcer could not be provoked in a single instance by profound stimulation of gastric secretion with histamine in beeswax. In 3 of the 11 dogs, superficial gastric erosions were noted. In 7 dogs (Series II), in which

TABLE I.
Extensive Gastric Resection (75 per cent) with Short Affluent Loop.
Each dog was injected daily with 30 mg of histamine in beeswax.

Dog. No.	Wt. lb.	Operation	Avg. length of proximal duodenal loop	No. of injections	Survival days	Results
6	38	75% gastric resection with gastrojejunos- tomy	12 to 15 cm	40	40	No ulcer.
23	20	"		"	"	" "
24	47	"		"	"	" " few small sub- mucosal hemorrhages in gastric pouch.
28	27	"		"	"	No ulcer; small erosion adjacent to esophag.
46	26	"		"	"	No ulcer; few erosions in gastric pouch in jux- taposition to esophag.
48	35	"		"	"	No ulcer.
64	48	"		"	"	" "
82	36	"		"	"	" "
208	35	140 g of stomach re- sected.		45	45	" "
242	22	" " "		"	"	" "
203	42	155 g " " "		"	"	" "

the extent of the gastric resection was the same (75%), the only difference being that the afferent duodenojejunal loop was longer (27 to 78 cm), a gastrojejunal ulcer occurred following histamine stimulation in each instance. In a third series of 4 dogs with long afferent duodenojejunal loops which received no hista-

mine after gastric resection varying in extent from 50 to 75%, 2 (50%) developed spontaneous perforated gastrojejunal ulcer.

Discussion. These results suggest definitely that the antecolic anastomosis with a long proximal duodenojejunal loop, even when accompanied by an extensive gastric resection,

TABLE II.
Extensive Gastric Resection with Long Affluent Duodenojejunal Loop.
Each dog was injected daily with 30 mg of histamine in beeswax.

Dog No.	Wt. lb.	Operation	*Length of proximal loop cm	No. of injections	Survival days	Results
244	25	75% gastric resection with gastrojejunos- tomy; 128 gm of stomach resected.	27	45	45	Large jejunal ulcer op- posite the gastrojejunos- tomy.
246	35	" ; 130 gm of stomach resected.	27	45	45	Large jejunal ulcer opposite gastrojejunal stoma.
254	38	" ; 160 gm of stomach resected.	42	22	22	Generalized peritonitis; perforated jejunal ulcer.
162	42	75% gastric resection; 170 gm of stomach resected.	50	48	48	Large irregular gastro- jejunal ulcer 3 x 3.5 cm.
118	30	" ; 128 gm resected.	54	48	48	Large excavated gastro- jejunal ulcer 4 x 5.5 cm.
5	35	75% gastric resection with gastrojejunos- tomy.	78	12	12	Generalized peritonitis; opposite gastrojejunal stoma 4 x 3.5 cm.
4	34	"	78	3	3	Generalized peritonitis; perforated gastrojejunal ulcer in afferent loop.

* Average over all length of small bowel 310 cm.

TABLE III.
Extensive Gastric Resection (50 to 75 per cent). No Histamine Given.

Dog No.	Wt. lb.	Operation	Length of proximal loop cm	Survival days	Results
88	30	50% gastric resection with gastrojejunostomy.	78	*210	Sacrificed; no ulcer. (Over all length of small bowel 319 cm.)
98	25	"	78	420	Generalized peritonitis with perforated gastrojejunal ulcer. (Over all length of small bowel 323 cm.)
73	60	60% gastric resection.	144	338	Spontaneous perforation of a gastrojejunal ulcer with generalized peritonitis. The entire gastro-intestinal tract contained fresh and changed blood. (Over all length of small intestine 401 cm.)
74	48	75% gastric resection with gastrojejunostomy.	90	†	

* This dog was sacrificed. Neither an ulcer nor a fistula was found.

† Still living at 761 days; gastric resection done 12-16-42, negative exploration 1-30-45.

is not a satisfactory operation for ulcer in man. Man's small intestine is approximately twice the length of the small intestine in the dog. The length of the duodenum in man is stated by anatomists to vary between 25 and 30 cm. It has been common practice for some gastric surgeons to make the anastomosis 30 (Balfour)² or more (Lahey)³ cm beyond the suspensory duodenojejunal ligament of Treitz. Kiefer⁴ has reported a series of 173 extensive gastric resections for duodenal ulcer in which the incidence of gastrojejunal ulcer was 11.4%. In that series the antecolic long proximal duodenojejunal loop was employed in the anastomosis. In this clinic, a series comprising now more than 300 consecutive gastric resections, has been operated upon for ulcer, employing the criteria of a satisfactory operation for ulcer described elsewhere.⁵⁻⁸ In this group only one stomal ulcer has developed. The 75% gastric resection, employing a short afferent duodenojejunal loop with a retrocolic anastomosis made at or just proximal to the suspensory duodenojejunal ligament of Treitz has been standard practice in operating upon patients for ulcer in this clinic for several years.

Conclusions. Extensive gastric resection (75%) in dogs when accompanied by a long afferent duodenojejunal loop is followed by a

high incidence of spontaneous gastrojejunal ulcer. When histamine in beeswax is administered to such dogs, stomal ulcer occurs regularly. When gastro-intestinal continuity is reestablished by a short afferent duodenal loop in the Billroth II plan of operation, stomal ulcer after extensive gastric resection (75%) can not be provoked even when histamine in beeswax is administered.

It is obvious that a short afferent duodenal loop is an important component of a satisfactory operation when gastric resection on the Billroth II plan of operation is invoked in the surgical treatment of ulcer.

² Eusterman, G. B., and Balfour, D. C., *The Stomach and Duodenum*. W. B. Saunders Co., Phila., 1935. Fig. 326.

³ Lahey, F. H., and Marshall, S. F., *Surg. Gyn. and Obst.*, 1939, **69**, 498 (in legend of Fig. 14).

⁴ Kiefer, E. D., *J.A.M.A.*, 1942, **120**, 814.

⁵ Wangensteen, O. H., and Lannin, B. G., *Arch. Surg.*, 1942, **44**, 489.

⁶ Lannin, B. G., Hay, L. J., Judd, E. S., Jr., and Wangensteen, O. H., *Proc. Soc. Exp. Biol. and Med.*, 1944, **56**, 231.

⁷ Wangensteen, O. H., *The Medical Record and Annals*, Houston, Texas, June, 1943.

⁸ Wangensteen, O. H., *The Bull. Minn. Med. Foundation*, 1944, **4**, 82.