

Vagotomy and Antral Resection in the Treatment of Duodenal Ulcer: *

Results in 514 Patients

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THE OVER-ALL RESULTS of operative therapy for duodenal ulcer are at present generally satisfactory, but the surgeon continues to be plagued with a certain number of patients who experience undesirable long-term sequelae. Experience has shown that with the employment of the various operative procedures of general acceptance today for control of the ulcer diathesis, the problem of recurrent ulceration has not been entirely eliminated. By the use of an "adequate" subtotal gastric resection, removing two-thirds to three-fourths of the stomach, the incidence of recurrent ulceration has been greatly reduced, but on the other hand the occurrence of undesirable side effects, as excessive weight loss, nutritional problems, and anemias, continue to pose a major problem. Vagotomy combined with a drainage operation for the treatment of duodenal ulcer produces few undesirable side effects, but long-term follow up studies by most groups have now demonstrated a definite increase in the incidence of recurrent ulceration as compared to patients subjected to "adequate" subtotal resection.

As a result of having experienced some of the problems enumerated above in patients with these procedures, we became interested in the operation of vagotomy and removal of the gastric antrum.^{2, 11, 27} It was felt that this procedure should theoretically offer as much or more protection against re-

current ulceration as "adequate" subtotal resection, and at the same time, perhaps, be accompanied by less evidence of weight loss, anemia and other undesirable sequelae.

Dragstedt has conclusively demonstrated that the fasting continuous secretion of gastric juice in man is of nervous origin and is usually increased several fold in patients with duodenal ulcer. By performing a complete division of the vagus nerves, this secretion is abolished entirely. More recent work on the humoral phase of gastric secretion has confirmed the original postulates of Edkins,⁵ which state that a gastric secretory hormone is liberated from the mucosa of the gastric antrum in response to the presence of food. It has been shown that this secretion is also initiated by mere distention of the antrum with gas and by peristaltic activity. It is Dragstedt's impression that peristaltic activity is an even more potent stimulus for the release of gastrin than is contact of food with the antral mucosa. This observation assumes surgical importance when one considers the hypermotility and spasm of the pylorus as demonstrated in patients with duodenal ulcer. Extirpation and transplantation experiments⁴ performed in the experimental animal indicate that the antrum is the sole source of the hormone "gastrin." It appears likely that a comparable situation exists in man. By extirpation of the entire antrum, this phase of gastric secretion may be eliminated entirely,^{3, 16, 26} thus making it unnecessary to sacrifice a

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portion of the body or fundus of the stomach.

The beautiful and ingenious triple-phase total pouch experimental procedure devised by Sauvage^{18, 19} has been proven to be a potent ulcerogenic preparation. His particular experiments suggest that antral extirpation appears to offer greater protection against the development of ulceration than does vagotomy. Antral extirpation combined with cagotomy, however, seems to afford the experimental animal a considerable degree of protection against ulcer formation. The conversion of the three-phase pouch to a one-phase pouch in which only the intestinal phase of gastric secretion persists probably lowers the ulcer potential of the gastric juice sufficiently to prevent ulceration.

During recent years, communications from this institution have described a clinical experience in which vagotomy and antral resection have been utilized in cases of duodenal ulcer requiring surgical treatment.^{7-9, 12-14} The over-all results were reported as being quite satisfactory with a follow up period extending to several years. This experience has encouraged us to continue utilizing the combined procedure, as it is our conviction that the operation is founded on sound physiologic principles. The combined procedure is applicable to the massive bleeder who requires surgical intervention, as well as to the patient with an acute perforation. Thus, its usefulness is by no means restricted to the patient who has an elective operation for the control of duodenal ulcer. The majority of the patients treated by vagotomy and antrectomy have consistently demonstrated an achlorhydria of the residual gastric pouch to the stimulation of a test meal. Approximately 90 per cent of the postoperative patients have had no free hydrochloric acid in response to histamine. Anemias have been only rarely encountered in the entire group. Following complete vagotomy and antral resection,

the pH of the gastric juice has ranged from 4.5 to 7.

The present communication is presented in order to render an over-all account of our experience with vagotomy and antral resection during the past 12-year period. The report includes a further detailed follow up study of the patients previously reported, along with an assessment of results of the patients subjected to operation since the publication of the last communication. The minimum postoperative follow up period for the entire group of patients has been 16 months and the maximum follow up period now extends over 12 years.

Clinical Material

From January 1947 through December 1958, a total of 680 patients have undergone vagotomy and antral resection for treatment of complications of duodenal ulcer. This report, however, includes a detailed analysis of 565 patients of the total number who were operated up through December 1957, with a follow up period extending from over one to an excess of 12 years. The material comprising this study consists of private patients operated upon on the Surgical Service of the Vanderbilt University Hospital, staff cases from that institution, and patients subjected to operation on the Surgical Service of the Thayer Veterans Administration Hospital, Nashville, Tennessee.

Of the 565 patients, there were 18 hospital deaths (mortality of 3.1%). In addition, 18 patients have subsequently died over the years, but at the time of their demise none had symptoms referable to ulcer disease. Of the patients who survived, 15 have been lost to follow up. Thus, 514 patients, or 97 per cent of the total survivors, comprise the material for this report (Table 1).

Among this group of 514 patients, the age range varied from 22 to 81 years, with an average age of 47.1 years at the time of operation. The postoperative hospital stay averaged nine days in the private patients,

11 days in the staff patients, and 14 days among the patients operated upon at the Thayer Veterans Administration Hospital. The series consisted of 423 males and 91 females (ratio of 4 to 1). Pain refractory to medical management constituted the chief indication for operation in the largest number of patients (274, or 53.2%). One hundred and fifty-two patients, or 30 per cent, were operated upon for recurrent or massive hemorrhage; whereas, 80 patients, or 15.4 per cent, experienced pyloric obstruction necessitating surgical intervention. A small group of eight patients were subjected to immediate vagotomy and antral resection for the control of an acute ulcer perforation (Table 2).

It was noted that the duration of ulcer-like symptoms for the entire group prior to operation varied up to 40 years, with an average of 11.2 years. In a few instances, massive hemorrhage was the initial symptom requiring an emergency operation.

Hospital Deaths: The mortality rate following resectional surgery for duodenal ulcer in most surgical centers today usually ranges from 1 to 4 per cent. A mortality rate of 3.1 per cent in the present series is an acceptable figure when one considers that the group of cases is relatively large, nonselective, and represents both private and staff patients. It should be stressed that the series includes many poor risk patients with obstruction, massive bleeding and co-existent systemic disease. The operations were performed by several different surgeons. There was little or no discrepancy in the mortality rate of the group of patients operated upon by the resident surgeons and the mortality rate of the group of patients cared for by the senior staff.

Among the 18 hospital deaths, eight, or 44 per cent, occurred in patients subjected to emergency operation for control of massive hemorrhage. Seven of the eight patients were in the seventh and eighth decades of life and each was considered a poor surgical risk when first observed. Six

TABLE 1. *Study of Patients*

Total Number Patients	Hospital Deaths	Subsequent Deaths	Loss to Follow Up	Patients Followed
565	18	18	15	514

of these patients succumbed in the early postoperative period to cardiac or pulmonary complications. One patient died as a result of a fulminating, necrotizing pancreatitis. The eighth patient operated upon for the control of massive bleeding was suffering from pseudohemophilia and expired as the result of uncontrollable gastric hemorrhage despite a subsequent emergency total gastrectomy.

There were five deaths in middle-age and elderly patients subjected to operation for relief of pyloric obstruction. In three of these, death was attributed to complications associated with pre-existing cardio-renal disease. One patient succumbed to massive pulmonary embolism. The first patient died as a result of stomal obstruction and electrolyte imbalance despite two re-operative attempts to correct the stomal function.

One patient died of postoperative hemorrhage resulting from the excision of a pancreatic cyst carried out at the time of the vagotomy and antral resection. One death resulted from acute pancreatitis and one patient died from complications of a post-operative subdiaphragmatic abscess. A leaking duodenal stump was responsible for one fatality. Cardiac arrest, which occurred in a 67-year-old male, was responsible for one death. This took place when the patient underwent a second operation to relieve small bowel obstruction (Table 3).

TABLE 2. *Indication for Operation*

	Pain	Hemorrhage	Obstruction	Perforation
Patients	274 53.2%	152 30%	80 15.4%	8 1.4%

TABLE 3. *Mortality*

Number of Patients	Indication for Operation	Cause of Death
8	Massive hemorrhage	6 Cardiac } complications Pulmonary } 1 Acute pancreatitis 1 Pseudothrombophilia
5	Pyloric obstruction	3 Cardioresenal disease 1 Pulmonary embolus 1 Stomal obstruction
5	Pain	1 Postop. hemorrhage 1 Acute pancreatitis 1 Subdiaphragmatic abscess 1 Leaking duodenal stump 1 Cardiac arrest
18 Total		

If the eight deaths, which occurred in patients subjected to emergency operation for control of massive hemorrhage, are temporarily excluded, then a mortality rate of 1.7 per cent (10 deaths) exists in the series of patients who were subjected to elective resection for the control of duodenal ulcer.

Associated Procedures: At the time of vagotomy and antral resection, associated intra-abdominal procedures were performed on 37 of the 514 patients. Cholecystectomy for cholelithiasis was carried out in 17 instances, and three of the patients also underwent exploration of the common bile duct. The addition of the biliary tract procedures did not affect the postoperative morbidity to any degree except in one instance. This particular patient had a Billroth I reconstruction, along with vagotomy, antrectomy and cholecystectomy, and developed stomal obstruction during the early postoperative period. At re-operation he was found to have an adhesive band between the gallbladder fossa and the gastro-

TABLE 4. *514 Patients*

Vagotomy, antrectomy, Billroth I	175 patients
Vagotomy, antrectomy, Billroth II	339 patients

duodenostomy site which was the cause of the stomal obstruction. Splenectomy was required in seven patients due to accidental injury to that organ at the time of performance of the vagotomy. The associated procedure did not affect the moribidity among this small group. It was observed in each of the seven instances that the splenic tear took place in small, slender individuals with a shallow anterior-posterior diameter of the upper abdominal attic. In an individual of this particular build, the spleen usually lies on the same horizontal plane as the esophagus and is therefore much more likely to be injured while mobilization of the esophagus is being carried out. The remainder of the associated operations consisted of repair of an esophageal hiatal hernia in several instances, ventral herniorrhaphies, excision of a congenital duodenal diverticulum, and enucleation of a leiomyoma of the lower esophagus.

Significant Postoperative Complications: There were a total of 175 patients subjected to vagotomy and antrectomy with a Billroth I reconstruction; whereas 339 patients underwent vagotomy and antrectomy with a Billroth II type of reconstruction (Table 4). Exclusive of hospital deaths, there were 84 significant postoperative complications which occurred among 83 patients (incidence of 16.3%). In consideration of the complications not related directly to the gastro-intestinal tract or associated viscera, it was found that thrombophlebitis and wound disruptions were the complications encountered most frequently. Severe wound infections and pulmonary emboli were next in frequency. Cardiac arrest occurred in one case, and the patient was resuscitated with the usual measures.

Of the complications related directly to the resectional surgery *per se*, as would be anticipated, delayed gastric emptying was encountered most frequently. This complication took place in 24 patients and necessitated re-operation in eight of these. A leaking duodenal stump occurred in three

patients and acute postoperative pancreatitis was diagnosed in three instances. One patient developed a postoperative leak at the site of a gastro-jejunostomy and one patient developed a leak at the gastroduodenal anastomosis. After a rather stormy postoperative course, each patient recovered. Hemorrhage during the early postoperative period took place in five patients. In one instance, the bleeding occurred from a temporary gastrostomy site in the anterior wall of the stomach which had been utilized for the purpose of instituting gastric suction. Another patient bled rather profusely from a fresh suture line in the gastric pouch, but in both instances bleeding ceased spontaneously and reoperation was not required. In three instances, however, re-operation was necessary to control postoperative intra-abdominal hemorrhage. The site of bleeding in two of these cases apparently arose from small vessels along the lower esophagus which had not been securely ligated while performing vagotomy. In another case, bleeding from the descending branch of the left gastric artery was responsible for hemorrhage and postoperative shock. An operative injury to the common bile duct was inflicted in one patient in mobilizing a difficult and scarred duodenum. This was repaired primarily and no complications ensued. Also, one patient had the transverse colon inadvertently injured while separating that portion of the colon from an adherent duodenal wall. A fecal fistula resulted necessitating further surgery for its correction.

In the group of 175 patients in whom the Billroth I reconstruction method was utilized, obstruction at the gastroduodenostomy site, as manifested by delayed gastric emptying, occurred in 11 patients (6.3%). In six of the 11 patients, re-operation was necessary and either a posterior gastroenterostomy was performed or a Heineke-Mikulicz plastic procedure carried out at the stomal site. In the Billroth II group of 339 patients, delayed emptying occurred in

TABLE 5. Significant Postoperative Complications
514 Patients

Number Patients	Number Complications	Incidence
83	84	16.3%
	Thrombo-embolic phenomena Wound complications	
	Delayed gastric emptying 24 Pts.	
Billroth I	11 cases (6.3%)	Re-operation 6 cases
Billroth II	13 cases (3.9%)	Re-operation 2 cases

13 patients (3.9%). Further surgery for correction of this difficulty proved necessary in only two of the 13 patients (Table 5).

Follow up Studies

The entire group comprising 514 patients have been carefully followed from a minimum of 16 months to over 12 years (Fig. 1). The majority of the patients have been interviewed and examined repeatedly in the office or dispensary. In a few instances questionnaires or contacts with the referring physician were the methods by which follow up assessments were made. Many of the patients have been subjected to gastric secretory studies during the long range follow up period. Blood studies have been determined and in many instances barium studies of the upper gastro-intestinal tract were included. Of the 514 patients, 218 or 42.5 per cent, have been followed just short of five years. In the group of 175 patients with vagotomy, antrectomy, and a Billroth I reconstruction, the majority have been followed only one to four years, the longest period of observation in this group being seven years. However, among the 339 patients subjected to a Billroth II reconstruction, 61 per cent have now been followed almost five years.

Over-all Results: A critical appraisal has been made of the clinical result obtained in each of the 514 patients. The criteria used in grading results has been in-

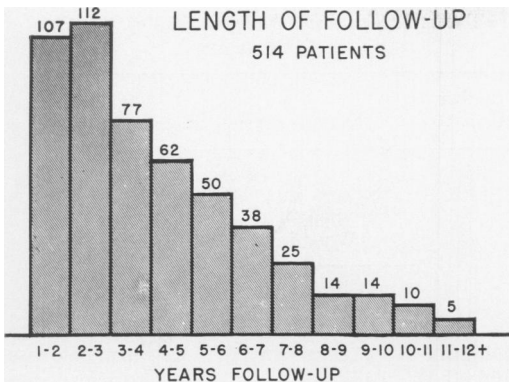


FIGURE 1

deed strict. A patient was considered as having obtained an *excellent* clinical result only if he or she noted no symptoms referable to the gastro-intestinal tract. This group experienced no dietary restrictions and for practical purposes were equivalent to a normal, healthy individual with a properly functioning gastro-intestinal tract. Under a *good* result was recorded the individual who had excellent gastro-intestinal function, but occasionally experienced epigastric fullness after meals, or mild dumping symptoms, or a mild diarrhea. In some circumstances it was difficult to catalogue patients in this group and the dividing line between an *excellent* and *good* result was at times indeed small. The patients considered as obtaining a *fair* result all received benefit from the operative procedure, but the resultant vague epigastric distress, abdominal fullness and diarrhea noted by the group constituted a source of distress to the patient and physician. The members of this group stated, however, that each had received benefit from the operation. No patient in the *fair* result group had objective or subjective evidence of recurrent ulcer disease. The *poor* results comprised two patients with recurrent ulcer disease and those who experienced abdominal distress and postgastroectomy symptoms of such severity as to interfere with their pursuing a livelihood. Each patient in this group was frank to admit that he or she was dissatisfied with

the result of the operation. While peptic ulcer was eliminated in all patients except two, it was felt by the examiners that the procedure otherwise was of no material benefit for any patient in this group.

The over-all results obtained among the 514 patients categorically broken down, as cited above, revealed that 315 patients (62%) have obtained an *excellent* clinical result. One hundred and fifty-nine patients (30%) have been listed as a *good* result and 24 patients (5%) have been termed a *fair* result. Sixteen patients (3%) received a *poor* result from the operation (Fig. 2).

Results in Relation to Type of Gastro-intestinal Reconstruction: The results were further compared in regard to the type of gastro-intestinal reconstruction performed in association with vagotomy and antrectomy. Of 175 patients who underwent a Billroth I reconstruction, 102 patients, or 59 per cent, have obtained an *excellent* result. Fifty-six patients (32%) are termed a *good* result and 10 patients (5%) are listed as a *fair* clinical result. Seven (4%) derived no benefit from the operation and were classified as *poor*. One patient in the latter group developed a recurrent ulceration. Three patients have continued to experience epigastric distress, have lost weight, and are dissatisfied with the result. None of the three patients has objective or subjective evidence of recurrent ulcer disease and blood counts are normal in each instance. Two patients developed stomal obstruction in the postoperative period necessitating a gastroenterostomy for relief in each case. Both patients are doing exceedingly well at present, but each must be classified as a technical failure from the standpoint of the original Billroth I reconstruction. One patient was alleged to have passed a tarry stool three years after operation and began to complain of epigastric distress. He was also confronted with domestic problems at the time, which no doubt contributed to his complaints. A gastro-intestinal barium study revealed a

deformity on the lesser curvature aspect in the region of the gastroduodenostomy which was thought to possibly represent a recurrent ulcer. However, the mucosal folds surrounding the deformity appeared normal. A Hollander test was negative and the patient had complete achlorhydria following stimulation of both a test meal and histamine. Blood studies were likewise normal. The patient, however, was re-explored and an adhesive band located between the stomal site and the inferior surface of the liver was responsible for producing a "tenting" effect at the stomal site, thus accounting for the deformity on x-ray. A generous gastrotomy and a duodenotomy were performed at the time and no evidence of ulceration was present.

In comparison there were 339 patients who had a Billroth II reconstruction, and 214 (63%) are classified as an *excellent* result. One hundred and two patients (30%) obtained a *good* result and 14 patients (4%) were listed as having a *fair* result. In nine patients (3%) the results were termed *poor*. In the latter group is included the patient with recurrent ulcer as previously cited. In addition, there were five patients who have continued to experience epigastric pain, but, again, repeated gastro-intestinal studies have failed to reveal a recurrent ulcer. There has been no gastro-intestinal bleeding in this group and none of the patients shows evidence of anemia. Two patients lost an excessive amount of weight during the postoperative follow up and each experienced dumping symptoms of such severity that the Billroth II was later converted to a Billroth I reconstruction. These two patients have since regained their weight and now have obtained a good clinical result. One patient fared poorly for several years following vagotomy and antrectomy, experiencing weight loss, anorexia and abdominal pain. A recurrent ulcer could not be demonstrated on repeated studies. He later was subjected to a small resection of the gastric

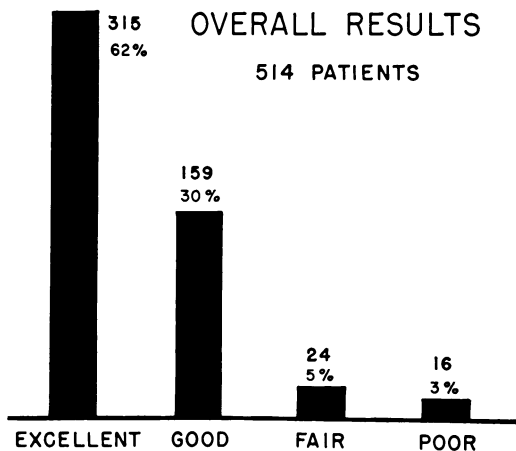


FIGURE 2

pouch with conversion of an isoperistaltic anastomosis to an antiperistaltic anastomosis. No recurrent ulcer was found at the second operation and the patient has since experienced a gratifying improvement (Fig. 3).

Results in Relation to Indication for Operation: The largest group of patients in this series were subjected to operation for intractable pain and 53 per cent have obtained an excellent result. A higher percentage of over-all excellent results was noted, however, in those patients operated for obstruction and hemorrhage, 69 per cent and 70 per cent respectively. The group operated on for acute perforation was too small to warrant a comparison (Table 6).

Results in Relation to Age: The majority of the patients fell in the age range from 30 to 60 years, but it was readily apparent that the middle and elderly age groups obtained a better over-all clinical result than did the younger patients in the age range from 21 to 30 years (Table 7). This observation is in accord with reports of other observers.

Results in Relation to Sex: Although male patients far outnumbered the females (4 to 1), it was quite striking to note that 65 per cent of the males obtained an excellent result as compared to 42 per cent in the group of females. The over-all excellent

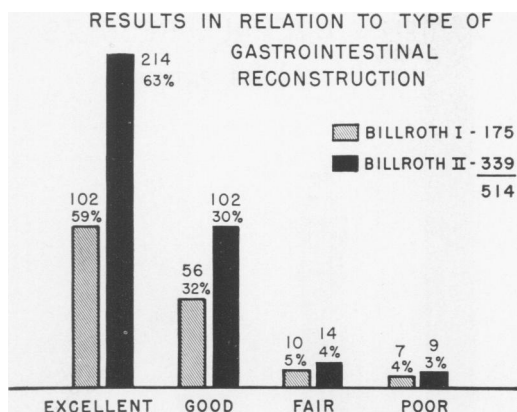


FIGURE 3

and good results among the 423 males comprising the series totalled 95 per cent; whereas, the combined excellent and good results in the female sex totalled 84 per cent (Table 8). Some of our poorest results have occurred in women.

Occurrence of the Dumping Syndrome: The postprandial symptoms characteristic of the dumping syndrome as experienced by the patients were classified as *mild*, *moderate* or *severe*. In instances, symptoms graded *mild* could only be elicited on careful questioning and for the most part have not served as a source of distress to the patient. The symptoms have been graded as of *moderate* severity if they occurred with any degree of frequency, but here they

TABLE 6. Results in Relation to Indication for Operation
514 Patients

	Excel- lent	Good	Fair	Poor	Total
Pain	146 53%	96 35%	18 7%	14 5%	274
Bleeding	106 70%	42 27%	3 2%	1 1%	152
Obstruction	55 69%	22 27%	2 3%	1 1%	80
Perforation	6 75%	1 12.5%	1 12.5%		8
					514 Pts.

TABLE 7. Results in Relation to Age

Ages	Excel- lent	Good	Fair	Poor	Total
21-30	22 45%	24 49%	3 6%	0	49
31-40	68 59%	39 34%	3 3%	4 4%	114
41-50	91 61%	46 30%	7 4%	6	150
51-60	81 61%	38 30%	9 6%	4 3%	132
61-70	43 75%	9 16%	2 4.5%	2 4.5%	56
71-80+	10 77%	3 23%			13
					514 Pts.

were, for the most part, completely controlled by the usual dietary and instructive measures. The dumping was classified as *severe* if the symptomatology was indeed pronounced and if it were of major dietary and nutritional concern to the patient and the physician. Here the symptoms were not always controllable as was true with the other groups.

Among the 514 patients, symptomatology suggesting the dumping syndrome was experienced to some degree in 152 (30%). In the Billroth I group of 175 patients, there were 50 instances of the dumping syndrome (29%). The dumping was *mild* in severity as evaluated in most patients. It is of significance that not a single case of severe postprandial symptomatology has occurred in this group. In the Billroth II group comprising 339 patients, symptoms of dumping were brought out upon careful interrogation in a total of 102 patients (30%). Again, the dumping symptoms were *mild* and transient in the majority of these cases. In three patients, however, the symptoms were of such a *severe* nature that two subsequently became totally incapacitated. Both patients have since undergone conversion of the

TABLE 8. Results in Relation to Sex

	Excel- lent	Good	Fair	Poor	Total
Male	276 65%	122 30%	17 3%	8 2%	423
Females	38 42%	38 42%	7 8%	8 8%	91
					514 Pts.

Billroth II reconstruction to a Billroth I. Each has gained weight, the symptoms of postprandial distress have disappeared and both patients have returned to their former occupation. The third patient who has *severe* dumping has lost 50 pounds in weight over a period of several years, but manages with considerable effort to continue her duties as a registered nurse (Fig. 4).

Postoperative Weights: In general, it may be stated that during the follow up period after vagotomy and antral resection, the majority of patients have not lost below their average or ideal weight. Many of the patients, particularly in the group operated on for intractable pain, have been found at the time of operation to average 10 to 30 pounds above the ideal weight. It is not unusual for members of this group to lose 10 to 20 pounds following operation and then stabilize their weight at the ideal level. Excessive weight losses following surgery have chiefly been encountered in that group of patients who are below ideal weight prior to operation.

A truly accurate comparison of the preoperative, postoperative and ideal weights could not be determined among a number of patients operated on at the Thayer Veterans Hospital and, unfortunately, hospital records were not complete as regards weights among many of the staff cases operated on at the Vanderbilt University Hospital. However, from the 307 private patients in the study, an assessment of weight status has been accurately determined: Among 107 patients with vagotomy, antrec-

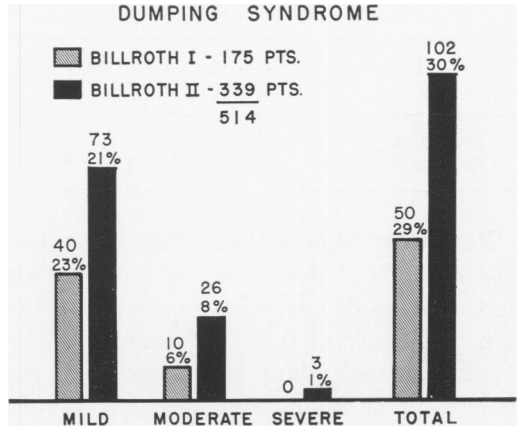


FIGURE 4

tomy and Billroth I anastomosis, 9 per cent have gained above their ideal weight since operation, 81 per cent have either maintained their ideal weight or gained to their ideal weight following operation, and 10 per cent of the group have lost below the ideal weight during the follow-up study. The weight loss in this latter group has averaged 10 to 15 pounds. The largest amount of weight loss experienced by a single individual has been 30 pounds.

In the group with vagotomy and a Billroth II reconstruction totalling 200 private patients, 6 per cent have gained over and above the ideal weight, 77 per cent have stabilized their weight at the ideal level, and 17 per cent of the patients have lost weight to a figure below what is termed the ideal weight. The weight loss among this latter group has ranged from 10 to 50 pounds, with the average weight loss being 15 pounds (Fig. 5).

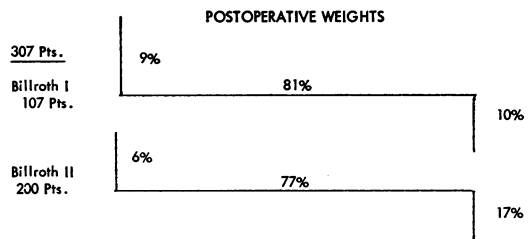


FIGURE 5

TABLE 9. *Recurrent Ulceration*

	No. Patients	Recurrent Ulcer
Billroth I	175	1 } 0.38%
Billroth II	339	

Recurrent Ulceration: During the follow up study to date, there have been two patients who developed a recurrent ulceration (incidence of 0.38%) (Table 9). One recurrence took place in a 57-year-old female who originally underwent a simple gastroenterostomy elsewhere for an obstructive duodenal ulcer. Relief of symptoms followed, but eight years later she again experienced severe epigastric distress, and on roentgen study was found to have an active duodenal ulcer, a gastrojejunal ulcer and a large antral ulcer, the latter probably occurring as a result of antral stasis due to a poorly placed gastrojejunostomy. The patient was treated by bilateral vagotomy, dismantling of the anastomosis, and an estimated 50 per cent distal gastrectomy with end-to-end gastroduodenostomy. She subsequently did well for an eight-month period, at which time she suddenly experienced massive hematemesis and melena. An emergency exploration was performed and a large recurrent ulceration with active hemorrhage was found on the posterior wall of the descending duodenum approximately 2 cm. distal to the stoma. A re-resection of the gastric pouch was performed with an anterior Polya reconstruction. Careful exploration of the pancreas failed to reveal an adenoma. Due to the patient's poor condition while on the operating table, it was deemed inadvisable to re-explore the periesophageal region for the possibility of an intact vagal nerve fiber.

Since the latter operation 24 months ago, the patient has had no further gastrointestinal symptoms. She has no free fasting hydrochloric acid in the residual gastric pouch and no free hydrochloric acid response on stimulation with insulin, hista-

mine or a test meal. It is indeed unfortunate, however, that gastric secretory studies were not obtained following the vagotomy and antral resection, as it has never been established whether or not the vagotomy was incomplete. The small gastric reservoir which she now possesses may well modify the response to insulin stimulation.

The second recurrent ulceration took place in a 44-year-old male veteran. This patient developed a marginal ulcer two years after undergoing vagotomy, antrectomy and a posterior Hofmeister reconstruction. Insulin test was strongly indicative of residual parasympathetic activity. He subsequently underwent a transthoracic vagotomy, at which time an intact vagal trunk extending to the stomach was identified and divided. Unfortunately, this patient developed an esophageal fistula with posterior mediastinitis which proved fatal.

Discussion

The combination of complete vagotomy and antral extirpation is now well recognized as an effective therapeutic procedure for the control of duodenal ulcer. The virtues of the operation are not restricted merely to the abolition of certain physiologic mechanisms, but from the pathologic point of view any of the complications of duodenal ulcer may be readily controlled by utilizing the combined procedure.

The importance of the antral mucosa as a perpetuating factor in the genesis of duodenal ulcer has been questioned by some, but there is convincing experimental and clinical evidence to suggest that it plays an important role in this regard as well as in stomal ulceration. This is exemplified in the work of Oliver,¹⁵ who demonstrated the inhibitory effect of vagotomy and antral resection on the development of jejunal ulcer in the Mann-Williamson dog. In turn, jejunal ulceration was readily produced by leaving the antrum or a portion thereof intact.

The increase in Heidenhain pouch secretions observed following vagotomy and a properly placed gastrojejunostomy with the resultant total abolition of these secretions produced by removal of the antrum adds further evidence that the gastric antrum is the source of an important secretory mechanism. The beautiful antral transplantation experiments of Dragstedt also support this concept.

In recent years Pearse and Schilling²⁰ performed 75 per cent gastric resection in the experimental animal with concomitant gastrojejunostomy. In one group a portion of the pyloric antrum was excluded, but otherwise left intact, and in another group the entire antrum was removed. After stimulation of both groups with histamine, they observed a 90 per cent incidence of recurrent ulceration in animals with the excluded antrum and a 20 per cent incidence of ulceration in the remaining group.

Clinical evidence supporting the role of the retained or excluded antrum in the perpetuation of ulcer disease has been stressed in numerous reports, noteworthy among which is the recent communication of Bales and Schilling.¹ Waddell²³ has shown that after antral exclusion and high proximal gastrectomy the remaining gastric pouch is still capable of responding to various physiologic stimuli. Following completion of the antrectomy, the responsiveness to these stimuli is reduced or abolished.

More recently Waddell and Bartlett²⁴ have performed vagotomy and a sleeve resection of the stomach with antral exclusion in a series of patients. They believe that the secretory effect of the antrum is nullified by vagotomy, which in terms of their hypothesis reflects the interruption in part of the efferent stream of cholinergic impulses to the parietal cell area. The fallacy of this concept, however, was recently brought to our attention when we encountered a patient who had continued to develop multiple recurrent ulcerations despite a complete vagotomy and multiple re-resections of the

gastric pouch performed elsewhere. A small 2 cm. cuff of excluded antrum was found at our exploration and following its removal the marginal ulcer healed completely.²² This clinical experiment further substantiates the original postulates of Edkins and Tweedy⁶ and the clinical observations of Von Eiselsberg as regards antral stimulation. The development of marginal ulceration after complete vagotomy and gastroenterostomy and of recurrent duodenal ulcer after vagotomy with pyloroplasty with resultant healing of these ulcers following subsequent antrectomy again reflects the importance of antral secretory activity. Whether or not one is in complete accord with the concept of antral secretory activity in the genesis of duodenal ulcer, the fact remains that our clinical experience demonstrates that the combined procedure of complete vagotomy and antral extirpation is extraordinarily effective in preventing recurrent ulceration.

In the present series an operative mortality rate of 3.1 per cent among 565 patients is higher than we would like and it is in excess of some reported series. However, if patients who were operated on for control of massive hemorrhage are excluded, the resultant mortality rate of 1.7 per cent falls within average range. Perhaps greater emphasis should be placed in the future on methods directed toward lowering the risk of ulcer surgery in the elderly age group with coexisting constitutional disease. A compromise operation of less magnitude such as vagotomy and pyloroplasty for this type of individual may be worthy of consideration. It is of interest that Weinberg²⁵ has successfully used vagotomy and pyloroplasty with transfixion of the bleeding vessel in a number of his elderly patients who have undergone surgery for the control of massive hemorrhage.

In our patients treated by vagotomy and antral resection, the over-all satisfactory results among the Billroth I and Billroth II groups have been approximately equal

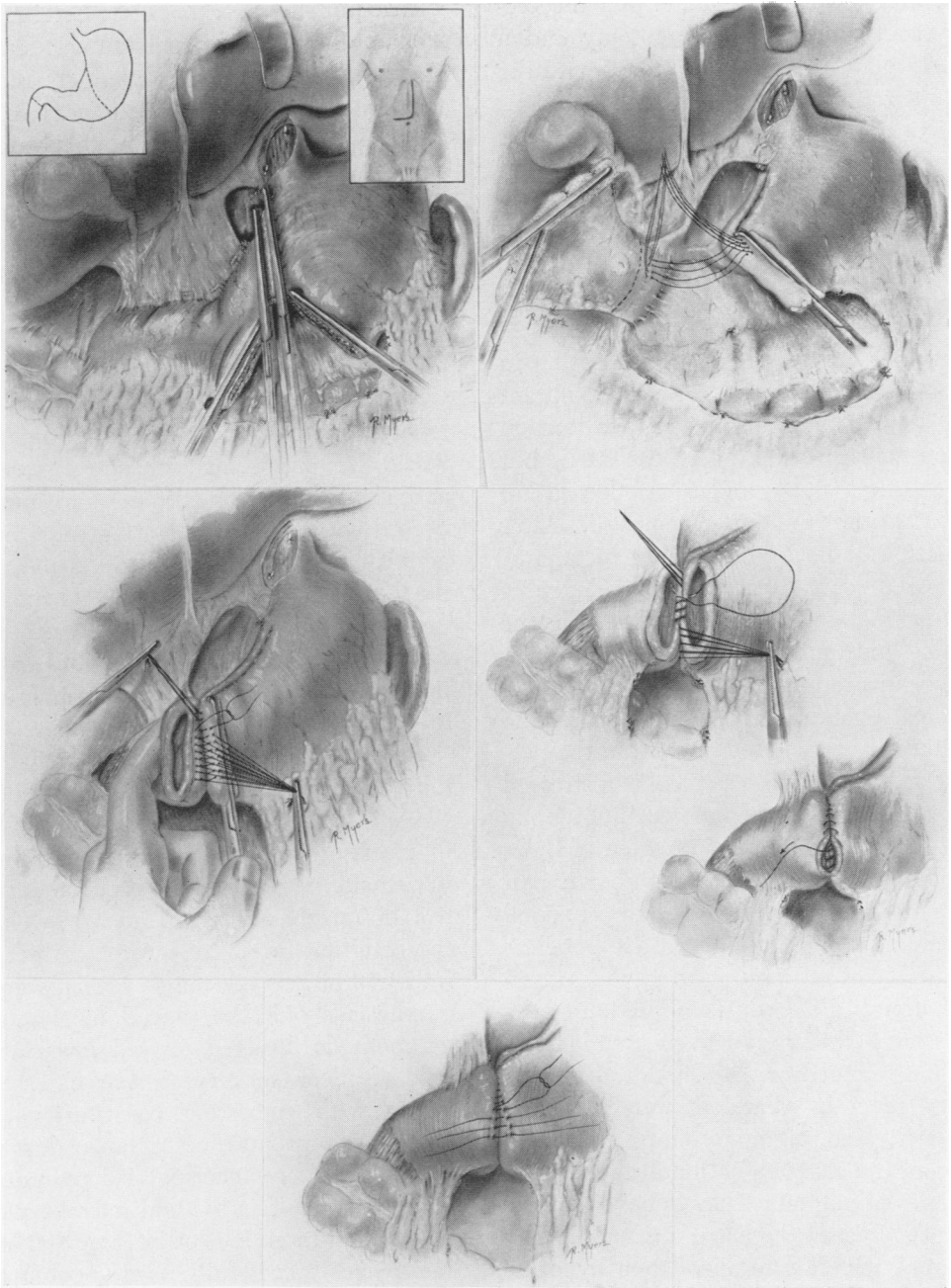


FIGURE 6

(91% and 94% respectively). Only one instance of recurrent ulceration has appeared thus far in either group and evidence of an incomplete nerve section was conclusively demonstrated in the single pa-

tient who developed a recurrence following a Billroth II reconstruction. The exact cause of recurrent ulcer in the other patient is not clear. The occurrence of the dumping syndrome has been demonstrated to take

place with approximately equal frequency in both groups, but it should be emphasized that not a single instance of severe dumping has occurred in patients who have had a Billroth I reconstruction. Excessive weight loss following operation was only rarely encountered in either group and it is felt that this is in large part attributable to the conservative resection accompanying vagotomy. The over-all percentage of weight loss, however, was slightly less in the Billroth I group as compared to those with Billroth II types of anastomoses.

Stomal obstruction during the early postoperative period was more frequently encountered among patients with the Billroth I reconstruction. However, it should be stressed that most of these problems occurred during our early work with the procedure. As experience with the technic of gastroduodenostomy has increased, stomal obstruction has been rarely encountered. It is of interest, however, to note that two patients have been encountered who first developed stomal dysfunction several months following operation. The problem proved to be a mechanical one in which a fibrous band was found present, extending from the inferior surface of the liver to the stomal site, producing angulation at the anastomosis. This complication usually gives the roentgen appearance suggesting a recurrent ulcer.

During recent years it has been our preference, when technically possible, to perform a Shoemaker end-to-end gastroduodenostomy following bilateral subdiaphragmatic vagotomy and antral resection (Fig. 6). The procedure is utilized when the ulcer can be removed with safety. Up to the present we have not attempted the Billroth I reconstruction in patients with a postbulbar ulcer and have made it a policy to perform gastroduodenostomy only if the ulcer is completely removed. In the future, however, consideration may be given to the application of the Billroth I method to the postbulbar ulcer which has not bled

preoperatively. The Billroth I reconstruction following vagotomy and antrectomy appears to have certain physiological advantages over the Billroth II method and reports of other observers stress the improved nutritional states with a diminished loss of fecal fat and nitrogen associated with maintenance of duodenal continuity.¹⁰ Our experience suggests that the Billroth I reconstruction is the method of choice for nutritional reasons, especially in the female patient. The Billroth II method, however, remains the safest and preferred technic when a densely adherent, posterior wall, bulbar ulcer is present which cannot be completely removed.

We feel it is extremely important to instruct our patients in the early postoperative period in a well planned postgastrectomy dietary regimen. While only 30 per cent of the patients in this study had clinical symptoms of the dumping syndrome, previous studies by some of us²¹ have demonstrated that any individual who has lost the functional integrity of the pyloric sphincter has the dumping potential. Corollary experimental work and experience with the patients of this study have indicated that the high protein, high fat, low carbohydrate diet advised originally by Hayes, and later elaborated by Robinson and Pittman,¹⁷ is soundly based. Our patients are instructed in this diet and are advised to abstain from liquids with meals and for an hour or so after eating. They are warned of the postprandial symptoms which may occur following the excessive ingestion of carbohydrates. After a period of several weeks, during which the individual's tolerance to carbohydrate is assessed, this regimen can be relaxed toward a more normal fare with few restrictions in the majority of patients.

The clinical experience to date suggests that complete vagotomy and antral extirpation is an effective therapeutic procedure for the control of duodenal ulcer and its complications. The overall results have

been quite satisfactory thus far, and the incidence of recurrent ulceration is indeed very small. A longer follow up study may well prove the combined procedure to be significantly more effective in controlling the ulcer diathesis than is "adequate" subtotal gastric resection. Studies to date have convinced us that this procedure is associated with fewer undesirable long-term sequelae.

Summary

From January 1947 through December 1957 a total of 565 patients were subjected to vagotomy and antral resection for the complications of duodenal ulcer.

The operative mortality rate in this group of patients was 3.1 per cent; if patients with emergency surgery for the control of massive bleeding are excluded, the mortality rate becomes 1.7 per cent. Exclusive of hospital deaths, patients lost to follow up, and patients subsequently dying of unrelated causes, a total of 514 patients, or 97 per cent of the total survivors, have now been followed for a minimum of 16 months to a maximum of over 12 years.

One hundred and seventy-five patients underwent vagotomy, antrectomy, and end-to-end gastroduodenostomy; whereas 339 patients had vagotomy and antrectomy with a Billroth II type of reconstruction. Only two patients among the 514, or 0.38 per cent, have developed recurrent ulceration.

The over-all excellent and good results among the Billroth I and Billroth II groups have been approximately equal, 91 per cent and 94 per cent respectively. The over-all incidence of the dumping syndrome has been approximately equal in both groups. However, it is significant that no instance of severe dumping was noted in the group undergoing the Billroth I reconstruction. Weight losses following operation have been slightly less in the Billroth I group, as compared to the Billroth II. Vagotomy, antrectomy and a Billroth I reconstruction

has been the preferred method in cases in which the ulcer could be completely and safely removed.

The over-all results with the combined procedure of vagotomy and antral resection have been quite satisfactory and in our experience thus far the operation appears to offer as much or more protection against recurrent ulceration than does an "adequate" subtotal gastric resection.

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DISCUSSION

DR. KEITH SANFORD GRIMSON: Dr. Ravdin and Members: We certainly want to congratulate Dr. Herrington and Dr. Scott on their excellent results in their approach to the ulcer problem. It has been about 30 years since surgeons gradually abandoned gastroenterostomy, with its high recurrence rate, in favor of subtotal gastric resection, with its gradually reducing mortality risk. Yet, today we still hear discussions of blow out of duodenal stumps, dumping syndrome and malnutrition. Vagotomy alone by Dr. Dragstedt, 17 years ago, was soon replaced by vagotomy and a drainage procedure because of faulty emptying of the stomach, which no longer has strong peristalsis. Adequate drainage accomplishes emptying because of the increase of resting intragastric pressure or tone. Like any other new procedure, vagotomy and gastroenterostomy was often improperly performed and abandoned or condemned without trial. A few groups of surgeons have continued

with the procedure gradually perfecting it. Other groups of surgeons have added vagotomy to their subtotal gastric resections trying to reduce their recurrence and complication rates. The decision today is whether 30 years have sufficiently improved subtotal gastrectomy, whether less radical resection and addition of vagotomy is better or whether vagotomy with gastroenterostomy or pyloroplasty has stood its test of 17 years. For comparison, I would like to summarize our results in 276 patients with duodenal ulcer treated since 1944.

The mortality rate is less than one-half of 1%. It is actually one patient in 276. Protection against recurrence of ulcer is 96%. Only 2% of the patients have required secondary operation, gastric resection. The incidence of incomplete vagotomy as judged by balloon and secretory tests has gradually reduced until there has been no incomplete vagotomy or recurrence in the last 5 years. Vagotomy and gastroenterostomy naturally involves a