

RESULTS OF VAGOTOMY DURING SEVEN YEARS

CLINICAL OBSERVATIONS AND TESTS OF GASTRIC SECRETIONS*

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EVALUATION OF VAGOTOMY, usually combined with gastro-enterostomy, began in June, 1944, and is continuing. Our last reports^{6, 7} acknowledged the original studies of Dragstedt and the contributions of others then interested in this method of surgical treatment of intractable or complicated peptic ulcer. The literature is now extensive. Many surgeons currently prefer subtotal gastric resection as their usual method of treatment for peptic ulcer, and others, experienced in the use of vagotomy and gastro-enterostomy, continue their preference for this procedure. A few surgeons, Colp,¹ Smithwick² and others, have recently recommended combining vagotomy with subtotal gastric resection and gastro-enterostomy.

It seems apparent that vagotomy and gastro-enterostomy can be accomplished with a lower mortality rate than that associated with subtotal gastric resection (Postlethwait¹¹); a lower incidence of serious complications soon after operation (Lyons¹⁰); and a low incidence of recurrence of ulcer.^{6, 7} However, there exists a difference of opinion with regard to the per-

centage of patients in whom vagotomy may be incomplete, the incidence and significance of gastro-intestinal disturbances following vagotomy and the duration of changes in gastric motility and volume and acidity of secretions.

A review has been made of the clinical results of vagotomy in all patients, 175, treated in Duke Hospital between June, 1944, and May, 1951, ascertaining their present condition by questionnaire and, when possible, by interview and examination. Also a review has been made of the secretory tests, including the "insulin test" and of gastrometric and roentgenologic studies. The clinical results will be presented first and a summary of the laboratory tests second.

CLINICAL OBSERVATIONS

Types of Operation, Location of Ulcer. Between June, 1944, and August, 1947, fifty patients were treated for duodenal ulcer, using vagotomy without gastro-enterostomy, a procedure then abandoned. Of these patients, 18 required secondary gastro-enterostomy and two, secondary subtotal gastric resection. Indications for operation were marked symptoms of gastric retention in 15 and recurrence of ulcer in five. Two of the remaining 30 patients with vagotomy alone died during the follow-up period, one of a cerebral vascular accident and the other a victim of homicide. The present status of another patient has not been determined.

* Read before the Southern Surgical Association, Hot Springs, Virginia, December 4, 1951. This investigation was supported by a research grant from the Division of Research Grants and Fellowships of the National Institutes of Health, United States Public Health Grant. Acknowledgment is expressed to Mr. and Mrs. Richard S. Newcomer for aid in assembling the results of insulin tests.

He was entirely all right and was well satisfied two years after the operation but has disappeared for two and a half years. Therefore, the present condition of 27 of the initial 50 patients treated by vagotomy alone for duodenal ulcer can be presented.* Between June, 1944, and August, 1947, patients with duodenal ulcer and marked obstruction were treated primarily by vagotomy with gastro-enterostomy, and since that time vagotomy and some form of gastro-enterostomy has been employed as the usual treatment for patients needing operation for duodenal ulcer.† Eighty-seven patients have now been treated by vagotomy with gastro-enterostomy and adding the 18 in whom secondary gastro-enterostomy followed vagotomy alone, the total number of patients is 105. Gastrojejunostomy, with a short afferent loop and a posterior anastomosis near the greater curvature and 6 or 7 cm. proximal to the pyloric sphincter, was the drainage procedure in 67 of these patients. Usually at the time of operation, a round or elliptical portion of the gastric wall 1.5 cm. in diameter was removed at the site of anastomosis to lessen the tendency of the stomach to close the opening as it contracts. Of this group of 67, one has since died of a myocardial infarction. An exclusion procedure, dividing the stomach 5 or 6 cm. proximal to the pyloric sphincter, closing the distal end and anastomosing the proximal end to the jejunum through an opening in the transverse mesocolon, was the drainage operation in ten patients. The remaining 28 patients

were treated by using pyloroplasty for drainage. Vagotomy was transabdominal in 23 and transthoracic in five. Of the 28, one died following operation, this being the single operative death among the total group of 175 patients. The operation was simultaneous transthoracic vagotomy and transabdominal pyloroplasty, the procedure used in five of these patients and now abandoned. Another patient of the 28 committed suicide four years after vagotomy because of matrimonial difficulty. Therefore, of the 105 patients treated by vagotomy and some form of gastro-enterostomy, the present condition of 101 can be described.

The diagnosis of duodenal ulcer was based upon roentgenologic and operative findings of a deformity or abnormality of the duodenum, including any at or near the base of the bulb. A number of patients in whom the lesion might have been a channel ulcer are therefore included. Since resection was not performed, careful examination of the relationship of the ulcer to the line of demarcation between gastric and duodenal mucosa was not possible. Only when a deformity at the outlet of the stomach was definitely recognizable roentgenologically and by palpation, as in the stomach, was a diagnosis of gastric ulcer made.

Nine patients with definite pre-pyloric or high lesser curvature gastric ulcer have been treated by vagotomy. This was done without drainage in four patients treated in 1945 and 1946, and no subsequent operation has been necessary. A fifth patient treated by vagotomy alone in 1946 required subtotal gastric resection five months later because of persistence of ulcer and bleeding. One patient received vagotomy and pyloroplasty in 1947. Another received vagotomy and gastro-enterostomy in 1950 because a large penetrating and adherent lesser curvature prepyloric ulcer was judged operable by subtotal gastric resection only with serious hazard to adjacent structures.

* The status of the 18 receiving secondary gastro-enterostomy will be described with the vagotomy-gastro-enterostomy group. The status of the two treated by secondary subtotal gastric resection will be considered with patients in the group who had stoma ulcer following previous subtotal gastric resection.

† Surgical services contributing patients to column M. W., Table I, usually used subtotal gastric resection for patients with duodenal ulcer.

Two patients died during the follow-up period. One treated by subdiaphragmatic vagotomy and pyloroplasty in September, 1947, did well until killed in an automobile accident March, 1949. The other, treated by vagotomy and gastro-enterostomy November, 1949, suffered extensively from neuritis, developed terminal myocardial infarction and, at autopsy seven months later, had extensive peri-arteritis nodosa. Therefore, the present status of seven patients receiving vagotomy for gastric ulcer can be reported.

Continuously since June, 1944, vagotomy has been the sole primary treatment for jejunal or stoma ulcer occurring after previous gastro-enterostomy or previous subtotal gastric resection. The operation has been employed in 28 patients. In no instance has any local resection or plastic procedure been attempted, even though gastric retention, large ulcer, or apparent narrowing of the stoma existed at the time of operation.

Jejunal ulcer followed previous gastrojejunostomy in 15 of the 28 patients. Operation was transthoracic vagotomy in ten. One of the ten had a complicated gastrointestinal disturbance with diarrhea and vomiting before operation, and although the stoma ulcer healed and pain was relieved, he experienced increasing difficulty with diarrhea, vomiting and malnutrition and died two years after vagotomy. Operation was transabdominal vagotomy in five patients, each now living. There are, therefore, 14 patients whose present status has been determined.

Jejunal ulcer followed previous subtotal gastric resection and was treated by vagotomy alone in 13 of the 28 patients. The present status of each has been determined. In an additional patient with jejunal ulcer following two previous subtotal gastric resections, the surgeon performed transabdominal vagotomy, resected the ulcer and more of the stomach, and led a Levin tube through a gastrostomy and through the new

gastrojejunostomy into the jejunum for subsequent feedings. Following this procedure, wound disruption occurred. Also a fecal fistula developed, but later healed spontaneously. Convalescence was delayed because of recurring gastric retention and intestinal colic, associated with visible hyperperistalsis of distended loops of small intestine. The insulin test was negative. Urecholine or Banthine were alternately used with little benefit. Nausea and vomiting, bowel colic, and a complaint of epigastric gnawing pain continued. Narcotic addiction and malnutrition contributed to death after 43 months. This patient is not considered in the discussion of results of vagotomy for stoma ulcer, since they deal with vagotomy alone. However, the two patients treated by secondary subtotal gastric resection following recurrence after vagotomy alone will be included with the 13 treated by vagotomy alone for stoma ulcer following resection when results of vagotomy and subtotal gastric resection are described in 15 patients.

CLINICAL RESULTS OF VAGOTOMY

Clinical results of vagotomy and gastro-enterostomy for duodenal ulcer ascertained in 101 patients are presented in Table I. Since it is recognized that results of any surgical procedure for ulcer may vary, depending upon the social and environmental status or economic security of the patients treated, as well as the experience of the operator with the procedure employed, results in Table I are divided into three groups. Group P includes 75 patients who entered the private wards and were personally treated by one of us, consistently employing vagotomy, usually with gastro-enterostomy. Group MW includes 26 patients, 25 entering the public wards and having the operation performed by one of several resident surgeons and one patient entering a private ward and treated by a surgeon who prefers subtotal gastric resection for duo-

denal ulcer, rarely performing vagotomy. The third group consists of all patients, the total of group P and MW. Although the total number of patients in each group is not adequate for accurate calculation of percentages, it is of interest that the percentage of patients completely satisfied was

TABLE I.—*Results of Vagotomy and Gastroenterostomy for Duodenal Ulcer.*

	Group P	Group M W	All Patients
Total number of patients.....	75	26	101
1. Satisfaction of patient			
Complete.....	57	23	80
Moderate.....	17	3	20
Dissatisfied.....	1	..	1
2. Ability to work			
Full time.....	62	22	84
Half time.....	10	3	13
Less.....	..	1	1
Retired.....	3	..	3
3. Reported weight relative to "normal weight"			
Greater.....	7	8	15
Equal.....	33	7	40
Less.....	35	11	46
4. Symptoms			
Ulcer Pain			
No.....	74	25	99
Yes.....	1	1	2
Appetite			
Good.....	48	12	60
Fair.....	27	14	41
Discomfort after eating			
No.....	55	16	71
Fullness, etc.....	20	10	30
5. Bowel habit			
1 to 2 movements a day... ..	53	19	72
2 to 4 movements a day... ..	13	4	17
Intermittent diarrhea.....	6	3	9
Persistent diarrhea.....	3	..	3

lower in Group P, 76 per cent, than in Group MW, 88 per cent.

The patients in each group are totaled under "all patients," Table I. Those having or describing difficulty will be discussed in general clinical terms to aid evaluation of the partially satisfactory or unsatisfactory results. There will be no description of the remainder or majority of the patients who definitely have clinically satisfactory results at present.

Three patients (3 per cent) have confirmed clinical evidence of recurrence of ulcer or occur-

rence of jejunal ulcer. Of these, 2 had a gastrointestinal hemorrhage requiring 2 or more transfusions. One receiving vagotomy August, 1949, reached 109 clinical units of free acid one-half hour after intravenous insulin before vagotomy and gastro-enterostomy, 56 units 2 hours after insulin at eight days, and 97 units three and a half hours after insulin at 6 months. Ulcer pain appeared nine months after vagotomy and hemorrhage occurred at 17 months. The other receiving vagotomy December, 1950, reached 57 units of free acid two and a half hours after insulin at 4 months. Hemorrhage occurred without preceding distress 10 months after operation. The third patient with recurrence had vagotomy December, 1947. There was no free acid during an insulin test 3 months after operation. However, 27 months afterward, moderate ulcer-like epigastric distress appeared, and when tested 28 months after surgery, 95 clinical units of free acid developed two and a half hours after insulin. Gastrometric studies, using 300 cc. intragastric balloons and recording with a bromoform manometer, revealed strong fluctuations of intragastric pressure in each patient, and vagotomy is assumed incomplete. Each patient is on continuing treatment, using 100 mg. of Banthine every 6 hours day and night and a moderately restricted diet. Each states that he is moderately well satisfied with the operation, works full time, has a good appetite, and does not now have ulcer pain. The 2 patients now describing ulcer pain, Table I, cannot be completely evaluated. One has not returned to the hospital for examinations but definitely states 7 months after operation that he has ulcer pain and has occasionally vomited blood and has had tarry bowel movements. He also describes pain at night and is taking Banthine. This patient is included in the clinically unsatisfactory result, though proof of recurrence and of completeness of vagotomy is not yet established. The other patient describes gnawing pains of slight intensity on a few occasions of late. The report is 3 years after operation and he states that he is completely satisfied. An insulin test 6 months after operation produced no free acid at any time. This patient is not considered as a clinically unsatisfactory result.

Another patient having an unsatisfactory clinical result is 1 of the 2 described in the previous report¹ as having a secondary operation to reduce an intussusception of the jejunum. At the present time, 5 years after vagotomy and 4 years after reduction of the intussusception and pyloroplasty, he states that he is only moderately satisfied, works half time and is not as strong as before the operations. Relief of ulcer pain has persisted but melena, which had occurred before with the intus-

susception, has again occurred on several occasions. An insulin test 4 months after vagotomy was associated with no free acid in any specimen.

Eleven of the 101 patients described moderate satisfaction but are nevertheless able to work full time. Each is relieved of ulcer symptoms. Of these, 3, whose drainage procedure was pyloroplasty, described a sensation of fullness or of delayed emptying of the stomach as reason for incomplete

of the back and legs. Another states that he feels subnormal and lacks energy and that his nerves are bad. The last patient, describing moderate satisfaction, though working full time, has symptoms attributable to pulmonary tuberculosis.

Five of the 101 patients describe themselves as able to work only half time, and of these, 4 are moderately well satisfied and 1 is dissatisfied. The dissatisfied patient developed dysphagia 2 weeks

TABLE II.—*Vagotomy Alone for Duodenal, Gastric or Stoma Ulcer.*

	Duodenal Ulcer*	Gastric Ulcer	Stoma Ulcer	
			Following Gastro-enterostomy	Following Subtotal Resection
Total number of patients.....	26	7	14	15
1. Satisfaction of patient				
Complete.....	21	6	10	8
Moderate.....	4	0	4	5
Dissatisfied.....	1	1	0	2
2. Ability to work				
Full time.....	22	4	9	7
Half time.....	3	1	2	4
Less.....	1	2	3	3
Retired.....	..	..	..	1
3. Reported weight relative to normal weight				
Greater.....	12	1	3	7
Equal.....	11	2	4	1
Less.....	3	4	7	7
4. Symptoms				
Ulcer pain				
No.....	25	7	14	13
Yes.....	1	0	0	2
Appetite				
Good.....	15	4	9	6
Fair.....	11	3	5	9
Discomfort after eating				
No.....	17	2	5	6
Fullness, etc.....	9	5	9	9
5. Bowel habit				
1 to 2 movements a day.....	16	4	10	10
2 to 4 movements a day.....	7	0	2	4
Intermittent diarrhea.....	2	3	2	1
Persistent diarrhea.....	1	0	0	0

* Remainder of original 50 treated by vagotomy alone for duodenal ulcer.

satisfaction. In each there is considerable retention of barium 6 hours after ingestion. Two patients are inconvenienced by a mild intermittent diarrhea, 4 to 7 stools, occurring at intervals of 1 to 4 weeks and aggravated by foods such as onions, green peppers, etc. Another is inconvenienced by looseness of bowel movements, 1 to 4 a day, and more frequent occurrence of diarrhea, 4 to 12 stools every few days. One patient describes episodes of dizziness and sweating occurring occasionally between meals and relieved by the taking of food or soft drinks. Another describes weakness, nervousness, dizziness and sweating occurring occasionally one-half hour after meals. One patient attributes his moderate satisfaction to being underweight, 152 instead of his normal 165 pounds, and to weakness

after operation and by roentgenographic study had a zone of narrowing in the lower 3 inches of the esophagus. This required a liquid diet for several weeks, following which symptoms subsided and the lumen of the esophagus opened, as observed by roentgenogram. He was then well and worked long hours until 2 years after operation, when severe cramping abdominal pain occurred one night and required hypodermics. The following day 3 or 4 tarry black bowel movements occurred. He recovered the following day and returned to work regularly. It was thought that he had experienced a temporary intussusception like that previously described¹ in 2 other patients. Nine months later the severe cramping abdominal pain again developed and recurred during a period of 3 weeks. His

FIG. 1

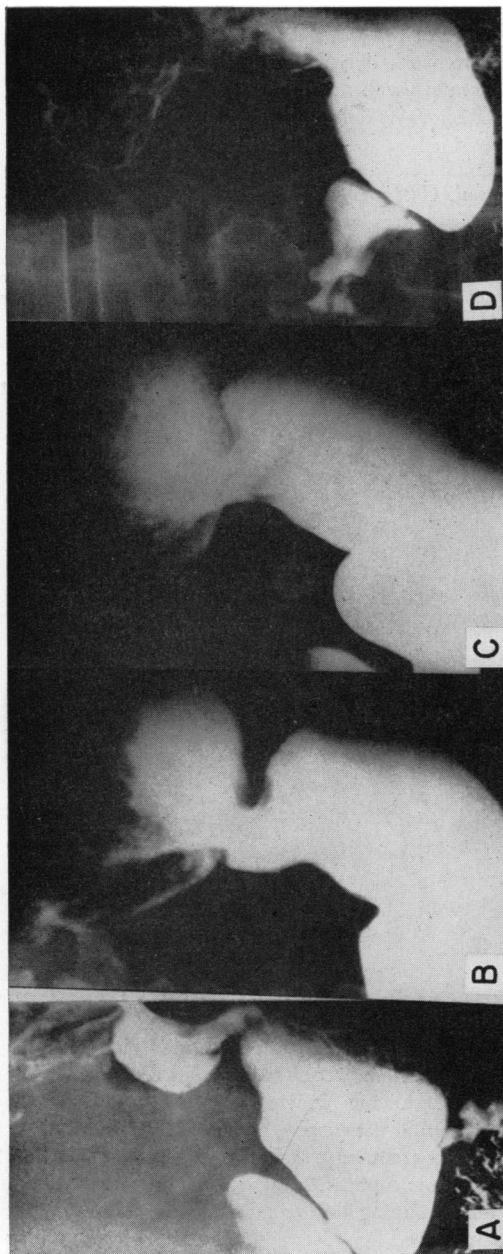
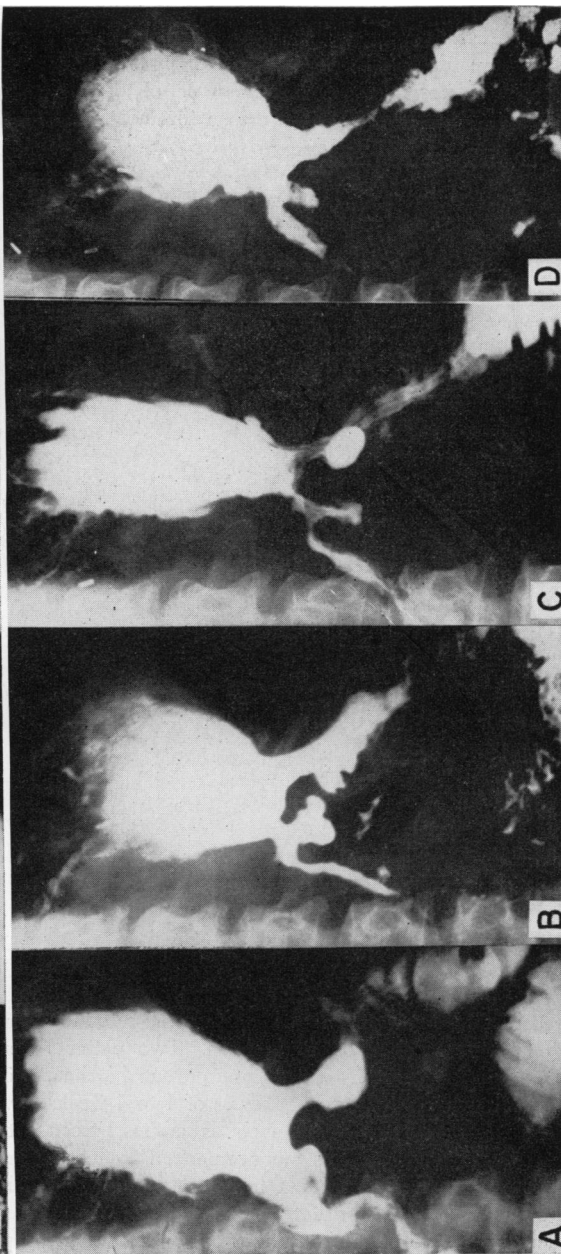


FIG. 2
(See opposite page for legends.)



family doctor gave him hypodermics. No melena occurred. At the present time, 2 months later, this patient is comfortable except for cramping discomfort after meals and loss in weight from a previous 230 to a present 147 pounds. This patient has a clinically unsatisfactory result and, although now considered as having recurring episodes of intussusception, might have other trouble. He will not yet agree to return for examination. Another patient in this group of moderately satisfied patients working half time describes a "knot" beneath the center of an old right rectus scar and constantly complains of pain and obstruction of food and gas at this site. At the insistence of the patient, and although he apparently had a typical gastric neurosis, an exploratory operation was performed at 1 year and 9 months to free adhesions in this area. No significant pathologic condition was encountered and the patient's complaint persists. One patient, age 72, states, 3 years following vagotomy and gastrojejunostomy, that he tires and needs rest. His weight equals his normal. Another describes weakness and palpitation one-half hour after breakfast and also says that his nerves are bad and that he lacks energy. His weight equals his previous normal. The fifth patient states that she tires easily and has bad nerves and headache. The remaining 5 patients list themselves as able to work only half time but are completely satisfied with the result of operation. One, though only 65, explains this disability by the additional 6 years of age. Two patients state their reason for working only half time as indifference. One gives hypertension as an explanation, and the other, constant use of alcohol.

It seems evident that the 27 patients moderately satisfied or working half time for reasons described fall into two groups. One includes seven patients whose treatment is considered clinically unsatisfactory because of definite or probable recurrence in four,

FIG. 1.—Large ulcer crater high on the lesser curvature of the stomach (A) has decreased in size eight days after vagotomy (B) and disappeared, leaving only an hour-glass deformity at three months (C). Six years and 4 months after vagotomy (D), a slight hourglass contracture persists but no ulcer could be found. The scar of a pre-existing duodenal ulcer is evident.

FIG. 2.—Two large jejunal ulcers (A) progressively decreased in size three months, (B) and 13 months (C) following completion of vagotomy. At 19 months (D) the craters had disappeared, but obstruction of afferent and efferent loops by scar tissue led to resection. The specimen revealed fibrosis but no ulcers.

intussusception treated surgically in one and diagnosed from symptoms in another, and because of diarrhea in one. The other group consists of 20 patients whose complaints vary from fullness after eating to simply indifference to work. Relief from ulcer without serious complications of operation might permit their classification as clinically satisfactory results to be grouped with the remaining 74 who unquestionably have good results from vagotomy and gastro-enterostomy, thus giving a total of 94 for the clinically satisfactory results in the 101 patients.

Clinical results of vagotomy alone for duodenal ulcer have been ascertained in 27 patients. One received transthoracic vagotomy for ulcer five years ago and at the same time bilateral transthoracic splanchnicectomy for severe hypertension. Although living at the age of 58, he is now incapacitated by arteriosclerotic cerebral degenerative changes. No difficulty followed vagotomy. Results in the remaining 26 patients are outlined in the first column of Table II. Patients entering public and private wards are not differentiated in Table II since the groups are small and no significant difference was noticed.

The patients having or describing difficulty will be discussed. One is now dissatisfied 6 years after vagotomy and works less than half time. He was well satisfied at the end of 4 years, though complaining of left chest pain along the incision. As judged by absence of free acid in gastric secretions, no free acid during insulin tests, and low fluctuations of intragastric pressure, the vagotomy was complete. A year later he was hospitalized because of increasing severity of the incisional pain. He was depressed and had recently divorced his wife, accusing her of attempted poisoning. Little could be done toward relief of pain, and he now refused to return for examination, stating that his back is tied up so that he can hardly walk, that there is pain in the incision all of the time, that he has pains in his stomach worse than ever, that he has vomiting spells, and that he is getting worse all of the time and can hardly live. Although he describes ulcer pain, the probability exists that this disability may relate to emotional disturbances

rather than to the vagotomy or to the ulcer. Two patients describe moderate satisfaction, and are able to work full time. One states that the operation upset his nerves and that he has gas. The other states that he is short winded on exertion and that his stomach does not empty well. One patient describes himself as able to work more than half time but as moderately satisfied because of weakness, easy fatigability, and incisional pain in the left chest. Two patients are completely satisfied with result of operation, though able to work only half time. One states that he is drowsy and tired, and the other offers no explanation.

The first of these six patients, although emotionally upset, is considered at present as having a clinically unsatisfactory result. The other five patients are considered as having satisfactory results for inadequate individuals and are grouped with the 20 unquestionably good results, giving a total of 25 good results among the 26 patients who as yet have only vagotomy and no drainage procedure.

Clinical results of vagotomy for gastric ulcer have been ascertained in seven patients, four treated by vagotomy alone, one by vagotomy and gastrojejunostomy, one by vagotomy and pyloroplasty, and one by vagotomy alone and four months later by high subtotal gastric resection. Results are listed in the second column of Table II.

The last patient, 4 years after subtotal gastric resection, describes herself as dissatisfied, able to work half time and nervous, but she appears clinically well for her present age, 73. Two patients work less than half time but are nevertheless completely satisfied. One, 6 years after vagotomy alone, performed for intractable pain from a large gastric ulcer located midway along the lesser curvature, has had no symptoms of ulcer since, and subsequent roentgenograms have demonstrated healing (Fig. 1). He has, however, always been a person disinterested in work or in co-operation. The other patient, satisfied but working less than half time, was treated by vagotomy and gastrojejunostomy for a large indurated, adherent and edematous prepyloric ulcer along the lesser curvature. The ulcer has evidently healed 1 year after operation but the patient is prematurely senile at 54 years of age and hasn't worked for several years.

In general clinical terms, each of these seven patients, and also the two previously described who died during the follow-up period, could be considered good results of vagotomy for gastric ulcer.*

Clinical results of vagotomy for stoma or jejunal ulcer following previous gastro-enterostomy have been ascertained in 14 patients and are listed in the third column of Table II.

One patient is considered as having a recurrence. He had first experienced epigastric pain in 1920. Two massive hemorrhages occurred in 1924 and 1925 and after the second a gastro-enterostomy was performed. Following this, 7 massive hemorrhages, each requiring several to as many as 12 transfusions, occurred at intervals. Transthoracic vagotomy was performed in 1947, and afterward insulin hypoglycemia produced 43 clinical units of free acid in the 2-hour specimen, 21 units in the two and a half hour specimen, but no free acid in the remaining 8 specimens. He was entirely relieved of pain and had no other symptoms for two and a half years, at which time a small hematemesis and associated melena recurred. Nine months later there was another episode of moderate bleeding, this time requiring hospitalization but not blood transfusion. Four months later the patient was re-examined. Fasting values of free acid were 32 and 28 clinical units on 2 occasions, and gastrometric studies revealed continued absence of fluctuations. Roentgenologic studies did not demonstrate ulcer. Operation was performed to determine the cause of bleeding. An old scar was present in the duodenum but there were no signs of active ulcer in the duodenum, stoma, or stomach. The antrum of the stomach was removed from the point of the gastro-enterostomy to the duodenum, and the specimen contained no ulcer. Nevertheless, it is assumed that this patient had recurrence of a small stoma ulcer following vagotomy.

* In no patient as yet has vagotomy been performed for a gastric ulcer which subsequently proved malignant, although this hazard exists and subtotal gastric resection is usually the preferred operation for this lesion. An error of diagnosis did occur in one patient not included in this series. Vagotomy was performed for relief of constant pain from a large ulcerating lesion judged an inoperable malignancy, though this was not confirmed by the biopsies. Subsequent roentgenograms 2 years later indicated complete healing.

RESULTS OF VAGOTOMY DURING SEVEN YEARS

Another patient with a 20-year history of duodenal ulcer bled after vagotomy. The surgeon first performed a gastro-enterostomy because of obstruction. Following this, wound disruption occurred and a month later a plastic revision of the gastro-enterostomy was performed because of continuing malfunction. The plastic repair fashioned a pouch out of the afferent and efferent loops in free communication with the gastro-enterostomy opening in the stomach, the pouch descending 2 inches. Two months later ulcer-like pain recurred. Roentgeno-

onstrated retention of barium in the pylorus beyond the gastro-enterostomy site. Nine months later melena recurred and 3 transfusions were given. The patient was then given Banthine. Two months later another episode of hematemesis developed and 2 transfusions were given. A month later he was re-examined. Roentgenologic studies revealed a very small slowly functioning gastro-enterostomy and delayed emptying of the stomach through it and through the duodenal bulb. Six months later this patient states that he does not

TABLE III.—Control Insulin Tests in Ulcer Patients.

Pt.	Before Insulin					After Insulin					
	½ Hr.	½ Hr.	1 Hr.	1½ Hr.	2 Hr.	2½ Hr	3 Hr.	3½ Hr.	4 Hr.	4½ Hr.	5 Hr.
H.C.	69	56	103	18	20	101	78	45	44	45	..
C.E.	48	53	35	38	50	112	105	100	..	..	..
C.C.	43	22	83	120	120	120	90	60	53	43	60
H.W.	55	95	125	132	129	122	85	90	91	92	..
J.H.	111	35	132	123	114	78	82	112	123	..	..
S.S.	15	110	82	56	27	43	50	2	5	18	..
J.Z.	45	24	46	78	61	73	49	80	53	51	75
G.J.	28	19	90	82	83	66	64	28	51	31	38
W.F.	25	22	95	96	100	100	79	55	25	32	42
F.R.	21	107	76	33	36	8	17	20	12	34	32
W.W.	84	56	81	88	102	110	115	114	107	106	109
S.D.	39	19	27	50	0	40	75	46	38	61	36

Note: Numbers represent clinical units of free acid in one half hour specimens (cc. N/10 HCl).

logic examination at 3 months demonstrated the pocket or pouch and an ulcer crater. Pain became more severe, vomiting and weakness developed, and 3 months later the patient was hospitalized with a hemoglobin of 49 per cent and occult blood in the stools. Medical management was continued another 5 months, at which time the patient was re-admitted because of constant severe pain requiring narcotics. Roentgenologic examination revealed the pouch or pocket and the jejunal ulcer. The surgeon performed a transthoracic vagotomy. Relief continued 6 months and then ulcer pain returned. Roentgenograms revealed that the ulcer was much smaller than on the previous study. Fasting gastric secretions contained no free acid. Medical management was continued. Four months later roentgenograms again demonstrated decrease of size of the ulcer. There was retention of barium in the distal part of the stomach. Although tarry stools were not noticed, his hemoglobin dropped 4 months later and a transfusion was given. Three months later tarry stools developed and 4 transfusions were given. He was again re-examined a few months later. Insulin hypoglycemia was associated with no free acid in gastric specimens at 2 hours, 59 clinical units at 3 and 42 at three and a half hours. Roentgenologic examination revealed findings consistent with a small ulcer and again dem-

onstrated retention of barium in the pylorus beyond the gastro-enterostomy site. Nine months later melena recurred and 3 transfusions were given. The patient was then given Banthine. Two months later another episode of hematemesis developed and 2 transfusions were given. A month later he was re-examined. Roentgenologic studies revealed a very small slowly functioning gastro-enterostomy and delayed emptying of the stomach through it and through the duodenal bulb. Six months later this patient states that he does not

have ulcer pain or melena, that he is well satisfied with the present results of treatment but is working half time because of "anxiety" that he again lose blood. Although this patient could be considered to have a recurrence of ulcer following vagotomy, the record would best indicate that there was delayed healing and that at the present time obstruction by scar tissue is developing. One patient in this group, with stoma ulcer treated by vagotomy, describes herself as moderately satisfied though working full time, and describes discomfort as fullness after eating and occasional loose stool with bowel cramps. Two patients describe themselves as moderately satisfied and able to work only half time. One was treated by subdiaphragmatic vagotomy for a stoma ulcer occurring 1 year after gastrojejunostomy elsewhere. During 29 years before the gastro-enterostomy and the year afterward, his complaint had been pain and vomiting. Three years before vagotomy he had been treated for a depressive episode. Following vagotomy his complaint was regurgitation of bile. A surgeon in another hospital took down the gastro-enterostomy but the patient still regurgitates, and now vomits food occasionally. The second patient moderately satisfied and working half time is also relieved of ulcer symptoms but describes himself as nervous, weak and experiencing

spells of vomiting of bile. Also there are occasional episodes of 1 day each during which several bowel movements occur. Two patients state that they work half time but are completely satisfied. One says that he is satisfied because there is no more passing of blood as before, but that he feels weak and tired, and the other, a father of 15 children, describes some intestinal cramping pains and elects full disability for personal reasons.

Clinical results of vagotomy for stoma or jejunal ulcer following previous subtotal gastrectomy have been ascertained in 13

The patient was then relieved of ulcer symptoms. However, she did experience fullness after eating and occasionally vomited food. Roentgenograms on two occasions revealed 20 per cent to 50 per cent retention of barium after 6 hours. Three years later intermittent ulcerlike distress recurred and progressed to constant pain with lower abdominal cramps. Roentgenograms revealed 2 small ulcer craters, 1 in the efferent and 1 in the afferent loop, and also persistent narrowing and retention. Banthine was prescribed, and the patient does not now have ulcer pain. Although an insulin test was not ordered, overnight gastric aspiration contained

TABLE IV.—*Insulin Tests Three to Seven Years After Vagotomy.*

Patient	Years After Vag.	Before Insulin	After Insulin									
			½ Hr.	½ Hr.	1 Hr.	1½ Hr.	2 Hr.	2½ Hr.	3 Hr.	3½ Hr.	4 Hr.	4½ Hr.
Vagotomy and Gastro-enterostomy For Duodenal Ulcer												
B.H.	3½	0	0	0	0	0	0	0	0	0	0	0
A.C.	3½	0	0	0	0	0	0	0	0	0	0	0
J.H.	3	0	0	0	0	0	0	0	0	0	0	0
W.S.	4	0	0	0	0	0	0	0	0	0	0	0
I.S.	4	0	0	0	0	0	0	2	13	7	7	..
C.F.	3½	36	0	12	7	14	25	13	32	30	30	22
C.W.	3½	0	10	27	28	26	19	26	16	38	28	..
R.B.	3	5	8	7	3	5	0	8	6	0	10	10
J.G.	4	40	7	5	12	14	22	20	34	29	50	36
M.R.	5	29	22	0	44	55	52	0	0	0	0	0
W.C.	5	12	0	5	0	0	1	0	0	0	7	..
M.G.	5½	4	36	49	67	89	70	44	0	37	39	18

Note: Numbers represent clinical units of free acid in one half hour specimens (cc. N/10 HCl).

patients. Results are listed in the fourth column of Table II along with results in two patients who had subtotal gastric resection following recurrence of ulcer after vagotomy alone, total 15 patients.

Three of the 13 with stoma ulcer present special problems. One who evidently developed recurrence gave an 8-year history of pain, had twice perforated and had had a subtotal gastric resection 5 years before vagotomy. Because of persistent pain, melena recurring every few months, and 2 episodes of hematemesis, another subtotal gastric resection was performed a year before vagotomy. Pain soon recurred, and at the time of her admission, roentgenograms revealed a small resected stomach, suggestive evidence of stoma ulcer and a dilated loop of jejunum which retained barium during a 24-hour period. The surgeon first explored the abdomen and released a chronic volvulus of the lower ileum, associated with dense scarring. The remainder of the stomach was not easily exposed because of scar, and the surgeon decided to do a transthoracic vagotomy. This he did 2 weeks later.

50 clinical units of free hydrochloric acid. The vagotomy may have been incomplete.

A second patient also presents a problem of development of obstruction. She gave a history of right upper quadrant pain and of 2 exploratory laparotomies during 2 years. Gastro-intestinal hemorrhage then occurred and required 5 transfusions. The roentgenologist found and the surgeon demonstrated perforation of the duodenal ulcer into the common bile duct. Operation was pyloric exclusion with resection of the distal two-thirds of the stomach. Epigastric pain recurred 1 month after operation. Roentgenologic examination revealed a small resected stomach and findings suggesting jejunal ulcer. Symptoms persisted 2 months and roentgenologic examination revealed 2 large jejunal ulcers and 50 percent retention of barium at 6 hours. The surgeon then performed a transthoracic vagotomy. Relief was complete, the patient gained weight but roentgenograms at 4 months visualized the craters. Retention was moderate. Free acid one hour after insulin was 59 units. During the next year the patient again experienced moderate epigastric discomfort and occasionally a choking sensation when swallowing,

but gained 25 pounds in weight. Because of persisting discomfort not relieved by use of diet and antacids the patient was transferred and a laparotomy was performed. The area of anastomosis between the stump of the stomach and the jejunum was involved in a large inflammatory mass which was adherent to the transverse colon. Two large ulcer craters existed, each 3 cm. in diameter (Fig. 2A). The peri-esophageal region was explored and one moderately large trunk and several strands of vagus were found and removed. Also the previously excluded stump of the antrum was excised. Eight days later an insulin test was associated with 41 units of free acid in the 2-hour specimens, 40 in the 3-hour specimen, there being no free acid in other specimens obtained during a 5-hour period. Three months later the craters visualized by roentgenologic examinations were smaller, but narrowing of the lumen of the jejunum was described and there was considerable retention of barium in the stomach at 6 hours. Symptoms were mild distress and choking on food. Nine months later the patient experienced occasional episodes of nausea and vomiting, and though tarry stools were not noticed, her hemoglobin dropped to 50 per cent. A transfusion was given and the patient was then started on Banthine. Anemia developed a second time 3 months later, and 4 blood transfusions were given. Two months later epigastric distress increased and black stools were noticed. An insulin test was associated with high values of 51 units of free acid at two and a half hours, and 62 units at four and a half hours. Another test produced a high value of 42 units at four hours. Roentgenologic examination demonstrated obstruction but no crater (Fig. 2D). Laparotomy was again performed. The previously indurated mass and the 2 large ulcer craters had disappeared, being replaced by localized contracting scar tissue. The afferent loop of the anastomosis was chronically obstructed and dilated to a diameter of 5.5 cm. The efferent loop was somewhat obstructed. The scar tissue was excised along with a narrow cuff of stomach and of the jejunum. Continuity was restored by lateral repair of the defect in the jejunum and a new anastomosis to the stomach. Pathologic report revealed fibrosis, chronic inflammation, and obstruction of the jejunum, but no stoma ulcer. Since this operation for relief of obstruction the patient has done well except for difficulty in swallowing caused by narrowing of the lower esophagus and treated by dilations. She is advised to continue the use of Banthine.

The third patient presenting a special problem following subtotal gastric resection, occurrence of

stoma ulcer and use of vagotomy, is the second of the 2 patients previously described¹ as having non-strangulating recurrent intussusception. Subtotal gastrectomy had been performed in 1944. Sharp cutting abdominal pain and diarrhea occurred within a month. A diagnosis of stoma ulcer was made when pain persisted and radiated to the back. Roentgenograms revealed a definite crater at the site of anastomosis, and 2 years after the resection a transthoracic vagotomy was performed. Because of recurrent episodes of severe colicky abdominal pain and associated melena, an exploratory laparotomy was performed 2 years later and an intussusception of the ileum 40 cm. below the ligament of Treitz was found and reduced. The sharp colicky abdominal pain recurred several times and a year and a half later exploration was again performed and revealed non-strangulating intussusception in 3 areas of the jejunum. In one area this recurred after reduction and during observation. This was the area of his previous intussusception and a 1-foot segment of this portion of the jejunum was removed. Repeated insulin tests produced no free acid. Two years later this patient states that he is not satisfied and is working less than full time because he is "sick after eating" and has occasional colic. He is 50 pounds below his normal weight and constantly takes paregoric.

One of the 13 patients receiving vagotomy for stoma ulcer states that he is moderately well satisfied but able to work less than half time. Symptoms of ulcer have been completely relieved since the vagotomy and reasons for disability are described as muscular and body aching, tiredness and lethargy at all times. This patient also describes occurrence of a vaguely localized constant epigastric abdominal pain every few months and insists that only hypodermics will yield comfort. He also states that unless he takes codeine regularly by mouth diarrhea will develop. Psychiatrists have not managed improvement. Another patient states that he is not physically able to work and is "not satisfied, though this is hard to explain." He does not experience diarrhea or colic, is relieved of ulcer pain, but is 25 pounds under his normal weight. A third patient describes moderate satisfaction and works half time. Although relieved of ulcer symptoms he is 20 pounds under his normal weight and is nervous. A fourth, though satisfied, works only half time stating "the operation was a complete success, my nerves are all my trouble now."

Two patients of the 15 listed on the fourth column of Table II had their subtotal gastric resection for recurrence after vagotomy alone rather than for stoma ulcer. Each is moderately satisfied. One describes weakness, sweating and nausea after

eating, though he works full time. The other works only half time, describes diarrhea lasting several days and occurring every month or two and a "weak stomach" after eating.

In general clinical terms, results of vagotomy for stoma ulcer following gastro-enterostomy in 14 patients, and following subtotal gastric resection in 13 patients, have been satisfactory except for recurrence of ulcer in two patients, delayed healing

ing completeness of vagotomy. In earlier reports^{4, 5} it was noted that effects of vagotomy on gastric secretions varied. The volume of secretions of the fasting stomach and the amount of free acid in each cubic centimeter were usually much less after vagotomy than before operation, but the values for combined acid in each cubic centimeter were greater. This observation has been confirmed by additional studies in

TABLE V.—*Insulin Tests Three to Seven Years After Vagotomy.*

Patient	Years After Vag.	Before Insulin		After Insulin									
		½ Hr.	½ Hr.	1 Hr.	1½ Hr.	2 Hr.	2½ Hr.	3 Hr.	3½ Hr.	4 Hr.	4½ Hr.	5 Hr.	
A. Vagotomy Alone for Duodenal Ulcer, No Drainage Procedure													
C.E.	3	0	0	0	0	0	0	0	0	0	0	0	
G.P.	4½	0	0	0	0	0	0	0	0	0	0	0	
M.H.	3	0	0	0	7	0	5	0	0	6	26	..	
G.F.	6½	17	4	0	4	27	0	0	0	0	0	..	
P.J.	5	0	0	0	0	0	0	16	27	6	18	11	
E.Y.	3½	0	0	0	0	1	28	4	0	7	19	6	
M.D.	3½	0	0	5	32	32	0	5	0	0	0	0	
A.W.	3	59	43	0	0	0	0	0	0	0	33	0	
D.V.	5	22	13	0	27	31	49	26	6	0	0	0	
L.H.	4	19	29	29	0	23	13	16	18	53	36	40	
B. Vagotomy for Stoma Ulcer Occurring After Gastro-enterostomy													
W.W.	4½	0	0	0	0	0	0	0	0	0	0	0	
E.M.	4	3	3	19	29	12	0	5	0	0	30	24	
J.S.	3	28	12	0	0	50	31	38	0	44	41	34	
C. Vagotomy for Stoma Ulcer Occurring After Subtotal Resection													
R.W.	5	17	4	11	21	37	0	0	8	11	33	39	
C.P.	3	0	43	67	41	65	54	0	0	0	..	..

Note: Numbers represent clinical units of free acid in one half hour specimens (cc. N/10 HCl).

with development of obstruction by scar tissue in two and occurrence of intussusception in one. Although the remaining 21 patients treated for stoma ulcer are considered as having satisfactory results in general clinical terms, it is evident that complete satisfaction of the patient and ability to work full time were least frequent among those whose stoma ulcer followed subtotal gastric resection. Moderate disability also existed for the two patients who had subtotal resection following recurrence after vagotomy alone and they are included in column 4 of Table II.

TESTS OF GASTRIC SECRETIONS

The Hollander⁸ insulin test is considered by many as an accurate means of determin-

ing completeness of vagotomy. In earlier reports^{4, 5} it was noted that effects of vagotomy on gastric secretions varied. The volume of secretions of the fasting stomach and the amount of free acid in each cubic centimeter were usually much less after vagotomy than before operation, but the values for combined acid in each cubic centimeter were greater. This observation has been confirmed by additional studies in the 175 patients, most of whom have been tested. It was also reported^{4, 5} that results of the insulin test varied, and that in tests of ulcer patients made before vagotomy a temporary decrease in the amount of free acid usually occurred during the first 30 to 45 minutes after insulin. Following this, and usually within the next hour, the maximum increase in free acid occurred. In tests after vagotomy, the maximum increase usually occurred later. Accordingly, the insulin test used during the last seven years has differed from the Hollander test in that observations have been continued throughout a five-hour period following insulin.

After a period of fasting, 12 hours or more, a Levin tube was introduced into the stomach and residual gastric content as-

pirated and discarded. During one or more half-hour intervals before insulin, and during the consecutive ten half-hour intervals after insulin, the suction tube was occluded. At the end of each half-hour interval the tube was opened and the content of the stomach aspirated, the patient being carefully rotated from side to side to facilitate removal of secretions. The amount of insulin employed was 15 units of regular insulin for small or undernourished patients and 20 units for all others. Blood sugars were determined three-quarters of an hour after intravenous administration of insulin, and these usually ranged around 55 mg. per 100 cc. Each patient exhibited symptoms of hypoglycemia.

Detailed results of insulin tests and of 12-hour overnight aspirations obtained at intervals after vagotomy will be presented in a separate report¹² relating these observations to gastrometric studies. In general, the gastrometric studies employing balloons filled with 300 cc. of air have been more consistent than the insulin test and have seemed more reliable as a method of judging completeness of vagotomy.

For the purpose of this report a summary of results of the insulin tests of 26 patients examined three to seven years after vagotomy will be given. First, since the test employed differs from the technic of Hollander, results of control tests in a group of 12 patients with duodenal ulcer and without vagotomy are presented in Table III.

It is evident in Table III that the specimens obtained one-half hour after insulin contained less free acid than the specimen during the half-hour before insulin in eight patients, and more in only three. The free acid of the twelfth patient, C. E., increased slightly during the first half-hour after insulin, decreased during the next three specimens, and reached its high, 112 cc. N/10 HCl, two and a half hours after insulin. Also it is evident that only two of the patients reached their highest acidity in the

first half hour and three at one hour. Another three patients reached their greatest acidity at one and a half hours and one at each of the subsequent intervals, two to four hours inclusively. The highest values reached in these ulcer patients without vagotomy ranged from 75 to 132 and averaged 111 cc. N/10 HCl.

A marked contrast exists between these control tests and those (Table IV) obtained in 12 patients three to seven years after vagotomy and gastro-enterostomy. Their range was 0 to 89, average 24 cc. N/10 HCl. Only one patient, M. G., reached a highest value, 89, which fell within the range of the control ulcer patients, and he is completely satisfied with the result of operation and has at no time during the five-and-a-half-year period had any epigastric distress. No patient with vagotomy and gastro-enterostomy reached the highest level during the first one and a half hours after insulin. Two reached theirs at two hours, two at three and a half hours, one at four hours, and three at four and a half hours. The remaining four patients were achlorhydric throughout the five-hour period following insulin.

A marked contrast also exists between the control tests and those (Table VA) in nine patients who, as yet, have vagotomy as their only operation for duodenal ulcer, no drainage procedure added. The highest values for free acid ranged from 0 to 53, average 26 cc. N/10 HCl. No patient rose into the range of the control group. One patient, A. W., reached his highest value, 43, during the first half-hour after insulin, and it is of interest that his fasting secretions were higher, 59 cc. N/10 HCl. It is also of interest that a year and a half after this insulin test, performed three years after vagotomy, recurrence of duodenal ulcer and development of a crater necessitated secondary gastro-enterostomy. The first patient listed in Table VA, patient C. E., is the one who had both splanchnicectomy and vagotomy. He developed no free acid after insulin.

The second patient, G. P., is the one who divorced his wife because of attempted poisoning, and he now complains of many symptoms, including those of ulcer. He has been included as a clinically unsatisfactory result because of possible recurrence. The fourth patient, G. F., has subsequently had a gastro-enterostomy because of retention. The remaining patients have clinically satisfactory results.

Tests after vagotomy performed for stoma ulcer occurring following gastro-enterostomy (Table VB) are of interest only in that each patient has a satisfactory clinical result, including J. S., whose value for free acid was 50 cc. N/10 HCl two hours after insulin. Tests after vagotomy for stoma ulcer occurring following resection (Table VC) are of interest only in that the two patients have satisfactory clinical results, though one, C. P., reached 67 cc. N/10 HCl one hour after insulin.

Although the results in Tables IV and V would seem to indicate that occurrence of high acidity during the insulin tests had no relationship to recurrence of ulcer, the results of insulin tests described in the text and not included in these tables give the impression that there is a relationship. These tests did not enter into the tables, since each was run less than three years after vagotomy. As described in the text, they usually showed high values for free acid, 97, 57, 95, 53, 59, and 59 cc. N/10 HCl. Two of these values are within the range of those of the control group, Table III. However, these six tests were selected and listed because the patients had recurrence of ulcer. Several other patients of the 175 had similar high values but are now clinically well. The usual values among those of the 175 who were tested resembled the values on Tables IV and V.

In general, the 12-hour overnight collections of gastric juice obtained in the 26 patients three to seven years after vagotomy corresponded to the values listed for the

fasting specimens obtained one-half hour before the insulin tests.

DISCUSSION

Although 28 of the original 50 patients treated by vagotomy alone for duodenal ulcer, and four of the five thus treated for gastric ulcer, have satisfactory clinical results, necessity for secondary gastro-enterostomy in 18 and secondary subtotal gastric resection in three discourages use of vagotomy without a drainage procedure. Vagotomy as the sole surgical treatment for duodenal ulcer was abandoned in 1947.

Results of vagotomy and gastro-enterostomy are encouraging. Of the three types of drainage procedure used, pyloroplasty was frequently followed by delayed emptying of the stomach, exclusion by rapid emptying of the stomach with occurrence of the "dumping syndrome," and the short loop posterior gastro-enterostomy gave best results. There seems to be no important difference between results among the private patients of one surgeon (Table I, Group P) and results among ward patients treated by several surgeons, Table I, Group MW. Such differences as exist indicate that the private patients less frequently describe themselves as completely satisfied, 76 per cent, and the ward patients more frequently, 88 per cent. The percentages for ability to work full time were also lower in the private patients, 81 per cent as against 85 per cent. The percentage of patients equal to or heavier than their previous normal weight is essentially the same in the two groups, 53 per cent and 54 per cent. Also, the incidence of intermittent or persistent and usually mild diarrhea is essentially the same, 12 per cent and 11 per cent. However, more of the private patients described good appetite, 64 per cent as against 46 per cent, and freedom from discomfort after eating, 73 per cent as against 62 per cent. For the purpose of evaluation, it seems justifiable to include the groups together.

Experiences following use of vagotomy in nine patients with gastric ulcer would indicate that vagotomy, preferably with gastro-enterostomy, has been an effective treatment. The risk of overlooking cancer might therefore be accepted in circumstances in which subtotal gastric resection would be a hazardous procedure or in circumstances such as juxta-esophageal gastric ulcer, which would require total gastrectomy. Ordinarily, subtotal gastric resection would be the operation preferred.

Experiences following use of vagotomy in 28 patients with stoma ulcer would indicate that vagotomy, preferably without local resection of the ulcer, has been an effective treatment for most patients. A few have required or may yet require further treatment.

It is recognized that a number of patients among the 175 describe some difficulty with frequent bowel movements or intermittent diarrhea. Pancreatic secretions diminish after vagotomy, (Shingleton¹³) as they may after subtotal gastric resection (Jones⁹). After demonstrating in selected patients defective fat absorption following vagotomy (Fox³) it was recommended that the few patients experiencing symptoms be placed on a low fat, high protein, high caloric diet. Of the 175 patients, however, only seven describing themselves as moderately or poorly satisfied experience diarrhea. Their diarrhea is seldom described as steatorrhea. More frequently it occurred in tense or anxious individuals of normal weight or developed after dietary indiscretions.

A number of patients among the 175 describe symptoms such as fullness after eating, bowel cramps, excessive gas, etc. These symptoms have not been a major cause of dissatisfaction. A major inconvenience, and occasionally a major concern, has been temporary malfunction of the gastro-enterostomy occurring in one patient in eight and necessitating gastric suction for several additional days in the hospital. Gastric reten-

tion usually became evident seven or eight days after operation. In three patients, malfunction continued three to four weeks, requiring parenteral alimentation, and then subsided spontaneously in two and required secondary operation to release adhesions in one.

If one calculates late results of treatment for the entire group of patients, 175, in terms of a clinical impression or personal opinion concerning satisfactory and unsatisfactory outcome, the percentage of satisfactory results would be 91.4 per cent. Moderately satisfactory results would be listed for four patients because of mild or temporary recurrence of ulcer and for another because of persistent diarrhea without malnutrition. Two patients have moderately satisfactory results because of delayed healing of stoma ulcer and ensuing development of partial obstruction by scar tissue. The remaining two patients considered having moderately satisfactory results are the two described in the text as dying at 24 and 43 months because of pre-existing complicated gastro-intestinal disorders. They are considered as having moderately satisfactory results rather than as having unsatisfactory results because they were relieved of ulcer symptoms. Therefore, the percentage of moderately satisfactory results would be 5.14 per cent. Definitely unsatisfactory results have been obtained in two patients because of the occurrence of major hemorrhage following vagotomy, in three because of recurring intussusception, proved for two and diagnosed in one and in one patient because of postoperative death. Therefore, unquestionably unsatisfactory results would be 3.43 per cent.

Occurrence of continued excessive gastric secretion in a few patients has been of concern. When denervation has apparently been incomplete, or when symptoms of recurrence have developed, Banthine has been used to supplement the vagotomy. Comparison of insulin tests in 26 patients

studied at three to seven years, and of control insulin tests in 12 patients with duodenal ulcer, reveals that moderately high values for free acid, 50 to 67 cc. N/10 HCl, are obtained occasionally after vagotomy, but that normal responses, 75 to 132 cc. N/10 HCl, were reached in only one patient, 89 cc. N/10 Hcl.

SUMMARY

1. Beneficial effects of vagotomy usually persist.

2. Insulin tests three to seven years after vagotomy have produced no free acid or less free acid than control patients in 25 of the 26 tested.

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