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VOLUME VII

CONTENTS

CHAPTER

I SURGICAL DISEASES OF THE PANCREAS

JOHN McMASTER WAUGH, M.D., Professor of Surgery, Mayo Foundation, and Chief of General Surgery, Mayo Clinic, Rochester, Minn.

II SURGERY OF THE BILIARY SYSTEM

WALTMAN WALTERS, M.D., D.Sc., LL.D., Professor of Surgery, Mayo Foundation, University of Minnesota; Surgeon, Mayo Clinic; Consulting and Operating Surgeon, Mayo Clinic, St. Mary's Hospital and Colonial Hospital, Rochester, Minn.

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HUGH ROLAND BUTT, M.D., Professor of Medicine, Mayo Foundation, and Consulting Physician, Mayo Clinic and St. Mary's Hospital, Rochester, Minn.

III THE VERMIFORM APPENDIX

BERNARD BOYSEN LARSEN, M.D., Assistant Professor of Surgery, Western Reserve University School of Medicine, Cleveland

IV MALFORMATIONS OF THE COLON AND MALIGNANT LESIONS OF THE COLON

CHARLES W. MAYO, M.D., F.A.C.S., Surgeon, Mayo Clinic, and Professor of Surgery, Mayo Foundation, Rochester, Minn.

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V SURGERY OF BENIGN DISEASES OF THE COLON

RICHARD B. CATTELL, M.D., D.Sc., Director, Lahey Clinic, Surgeon-in-Chief, New England Baptist Hospital, Boston

BENTLEY PRESCOTT COLCOCK, M.D., Surgical Staff, Lahey Clinic, Boston

VI SURGERY OF THE RECTUM AND ANUS

VERNON C. DAVID, M.D., D.Sc., Professor of Surgery (Emeritus), University of Illinois College of Medicine, Chicago

RICHARD KENNEDY GILCHRIST, M.D., Professor of Surgery, University of Illinois College of Medicine, Chicago

CHAPTER

VII INTESTINAL OBSTRUCTION AND CHANGES IN BODY CHEMISTRY
CAUSED BY IT

WILLIS D. GATCH, M.D., Chairman, Department of Surgery, St. Vincent's
Hospital; Attending Staff, Methodist Hospital, Indianapolis

VIII THE PERITONEUM

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Boston

CARROLL CAMERON MILLER, M.D., Assistant in Surgery, Harvard Medical
School, and Clinical Associate in Surgery, Massachusetts General Hos-
pital, Boston

IX HERNIA

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Johns Hopkins University School of Medicine, Baltimore

SAMUEL McLANAHAN, M.D., Assistant Professor of Surgery, Johns Hop-
kins University School of Medicine, Baltimore

X THE INJECTION TREATMENT OF HERNIA

AMOS R. KOONTZ, M.D., D.Sc., Assistant Professor of Surgery (Emeritus),
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XI DISEASES OF THE LIVER

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CHAPTER ONE

SURGICAL DISEASES OF THE PANCREAS

JOHN M. WAUGH, M.D.

SURGICAL ANATOMY OF THE PANCREAS

The pancreas is a soft, lobulated organ with a yellowish gray appearance. Its length after removal is from 15 to 20 cm. and its weight is about 87 Gm. Anatomically it is divided into the head, the neck, the body and the tail. From the head, which occupies the duodenal curve, arises the uncinate process. The latter projects posterior to the superior mesenteric vessels and is usually the most difficult portion of the head of the pancreas to mobilize and resect. The narrow neck connects the head and the body of the organ. The most distal or left portion, known as the tail, is usually in direct contact with the hilus of the spleen (Fig. 1).

Exposure.—Exposure of the pancreas can best be obtained through an upper abdominal transverse incision, which, after severance of the gastrocolic ligament, will permit palpation and inspection of the entire organ. If exploration of the head of the pancreas only is desired, this can be accomplished readily by means of a vertical upper right rectus incision, the lateral duodenal ligament being severed so that the fingers can be slipped behind the duodenum and the head can be mobilized for palpation and inspection. Usually the neck can be seen through the gastrohepatic ligament. The tail and adjacent body can be exposed through a vertical upper left rectus incision or left transverse or left subcostal incision with about equal ease. After the gastrocolic ligament has been severed, the organ can be visualized. If palpation is desired, as in searching for an islet cell tumor, the inferior edge of the pancreas can be easily elevated, permitting the fingers to explore the posterior surface.

Pancreatic Ducts.—The main pancreatic duct (duct of Wirsung) occupies the approximate midportion of the tail, body and neck, and the superior portion of the head. Its tributaries join it at right angles for the most part. Before its termination or juncture with the common bile duct to form the ampulla of Vater, the main duct is usually 3 to 4 mm. in diameter. The ampullary portion of the duct pierces the duodenal wall usually 7 to 9 cm. distal to the pyloric ring, at which point there is a projection on the medial wall of the duodenum known as the papilla of Vater. As has been shown by Mehnen, and Schmieden and Sebening, there is frequently much variation from the so-called normal arrangement of the terminal portion of the pancreatic and bile ducts.

The accessory pancreatic duct (duct of Santorini) is smaller than the main duct and is variable but usually empties into the duodenum

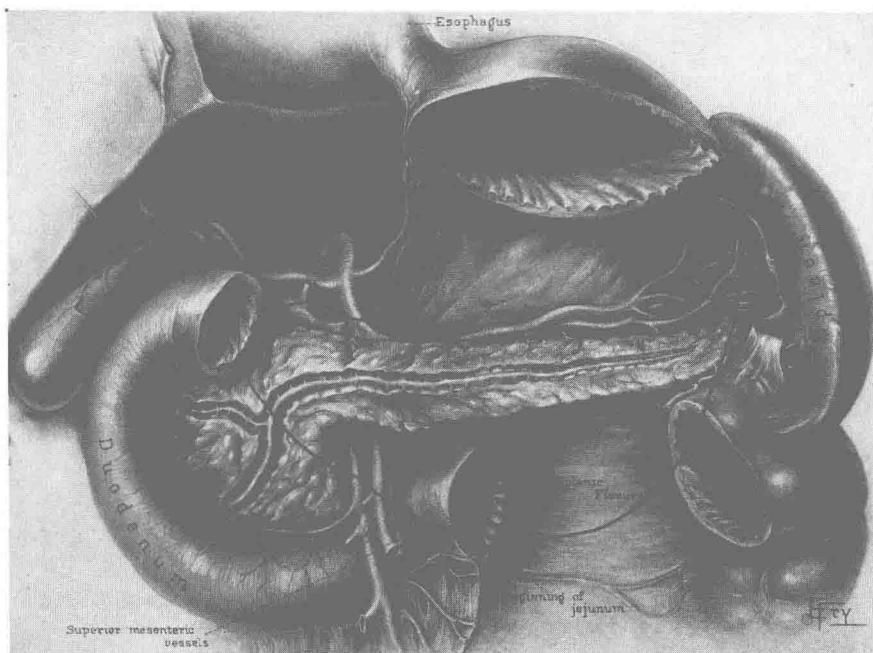


FIG. 1.—Anatomy of pancreas; relating to surrounding structures. (Reprinted from Walters, W. and Clagett, O. T.: *Surgery of the Pancreas*. In Piersol, G. M.: *The Cyclopedia of Medicine, Surgery and Specialties*, Philadelphia, F. A. Davis Company, Vol. X, p. 204, 1951.)

2 cm. proximal to the papilla of Vater and almost always communicates with the main duct in the head of the gland.

Relations.—Because of its position posterior to the stomach and colon at the level of the second lumbar vertebra, the pancreas rarely is injured without associated injury to the stomach, colon or duodenum. The head is bounded superiorly, laterally on the right and inferiorly by the duodenum. Posteriorly the inferior vena cava, the right renal vessels, the left renal vein and the aorta are in contact with the head. The adjacent neck is in contact posteriorly with the portal vein superiorly, and inferiorly the superior mesenteric vessels lie in the incisura pancreatis as they pass the head. The body is in contact posteriorly with the splenic vein, which occasionally may be just superior, with the splenic artery, the inferior mesenteric vein, the left renal vessels and the left kidney. The line of attachment of the transverse mesocolon is just anterior near the lower margin of the body and tail. The tail is in close proximity to the hilus of the spleen, with the splenic flexure of the colon just inferior and the stomach anterior.

Blood Vessels.—The superior pancreaticoduodenal artery, which is a branch of the gastroduodenal artery, courses inferiorly over the head and, by numerous small twigs to the substance of the pancreas, supplies the head as well as the duodenum. It anastomoses freely with the inferior pancreaticoduodenal artery, a branch of the superior mesenteric artery, which runs to the right and upward on the posterior

surface of the head. The body and tail receive three to five pancreatic rami from the splenic artery. The veins which drain this region follow the foregoing arteries and are tributary to the superior mesenteric and splenic veins. In addition there are several short veins located posteriorly, communicating with the superior mesenteric vein directly, which are of major significance in resection of the head.

Lymph Nodes.—There are five groups of lymph nodes associated with the pancreas which, no doubt, are concerned with drainage of lymph from different segments of the gland: (1) the biliary lymph nodes, which are found posterior to the common bile duct; (2) the subpyloric nodes, which are on the anterior and superior surface of the head; (3) the mesenteric nodes along the superior mesenteric vessels, some of which lie anterior to the uncinate process; (4) the right suprapancreatic nodes, which are along the superior border of the neck of the pancreas in close relation to the hepatic artery; (5) the left suprapancreatic nodes, which lie along the course of the splenic artery and extend into the gastrolial ligament.

Nerve Supply.—The hepatic plexus and splenic plexus send branches to the pancreas. Both are a part of the celiac plexus. The celiac ganglia are the chief ganglionic centers in the celiac plexus. Each celiac ganglion receives in its upper portion the greater splanchnic nerve, and the lower portion (aorticorenal ganglion) receives the lesser splanchnic nerve. The right vagus nerve also contributes to the celiac plexus.

Embryology.—The pancreas arises as two anlagen: the smaller, or ventral pancreas, from the common bile duct; the larger, or dorsal pancreas, from the duodenum. These two portions fuse as they develop to form a single organ drained for the most part by the duct of the ventral component. However, both ducts remain pervious and the proximal portion of the duct of the dorsal pancreas persists as the duct of Santorini, whereas the distal portion joins the duct of the ventral pancreas to form the main pancreatic duct or duct of Wirsung.

DISORDERS RELATED TO MALDEVELOPMENT OF THE PANCREAS

Annular Pancreas.—Annular pancreas is rather an anatomic curiosity. Essentially, it is a developmental anomaly of the ventral anlage of the pancreas in which this structure fails to fuse with the larger dorsal anlage. Instead, it develops independently and comes to surround the descending duodenum as a circular and at times constricting band.

In 1933 McNaught thoroughly reviewed the literature on the subject and presented a case which he had encountered at necropsy. This was the fortieth recorded case. During the ensuing seven years, seven more cases were reported, including a second addition by McNaught. In 1942 Lehman accomplished the rather remarkable feat of combining the clinical history with suggestive roentgenologic evidence and arriving at a correct preoperative diagnosis in what proved to be the forty-eighth authenticated case. Up to 1944 no additional cases were



FIG. 2.—Annular mass of heterotopic pancreatic tissue on the serosal surface of the pyloric ring. The roentgenologic report was as follows: "Annular lesion involving pylorus, prepyloric area and base of duodenum; shallow ulceration; impossible to exclude malignancy."

reported and the following case report (Custer and Waugh) was the forty-ninth. Only 11 of the 49 have been clinical problems; in the other cases the annular pancreases have been discovered incidentally during necropsy or on exploration in the operating room (Figs. 2 and 3).

REPORT OF CASE.—A farmer, 74 years of age, was of obviously superior Irish American stock since both of his parents had survived to the age of 80 years. The patient himself had been married 45 years and was the father of seven children. Further evidence of his own constitutional superiority lay in the fact that six years previously he had recovered completely from a serious head injury sustained in an automobile accident. He specifically denied other major illness in the past and, aside from questions relating to his gastrointestinal tract, the systemic review was essentially negative.

Mild to moderate distress in the form of irregular and episodic dyspepsia had been present in the upper regions of the abdomen for five years previous to the patient's registration at the Mayo Clinic. This type of disturbance had become definitely worse during the last six months of this period and during this time he had lost progressively from 20 to 25 pounds (9.1 to 11.3 Kg.). However, he had continued to perform heavy manual labor on his farm until three weeks prior to admission to the clinic when profound weakness developed while he was cutting grass on a hot day.

He attributed this weakness to overexposure to the sun. This episode was

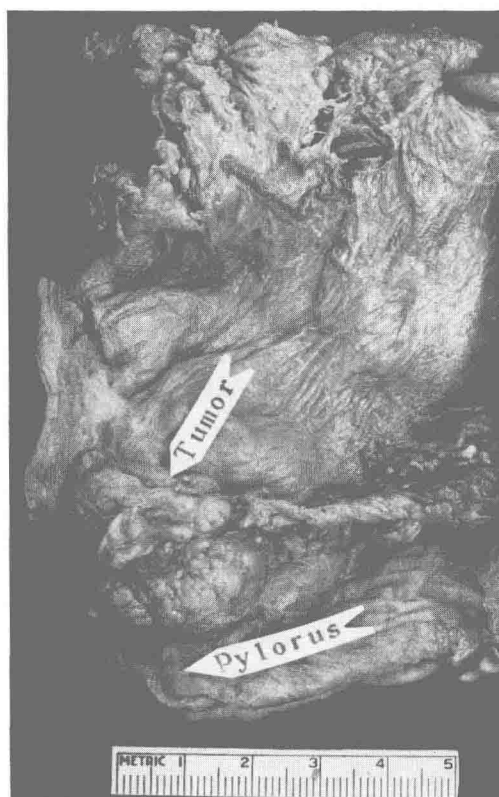


FIG. 3.—Specimen: 12 cm. of stomach and 1.5 cm. of duodenum. Heterotopic pancreatic tissue forming an annular mass, 3 cm. in diameter, on the serosal surface of the pyloric ring. The tumor in the picture is included between the points of the two arrows. It was causing pyloric obstruction and loss of weight; clinically, roentgenologically and grossly at operation it was mistaken for an adenocarcinoma of the stomach.

followed by recurrent obstructive vomiting on several days, and he was subsequently hospitalized in his home locality. He was referred to the clinic a few days later when his physician discovered on roentgenologic examination of the patient's stomach what he interpreted as a gastric neoplasm.

This impression was in concurrence with the findings at the hospital to which he was sent after admission to the clinic on July 16, 1943. Roentgenologic examination after the oral ingestion of barium a few days later revealed marked dilatation of the duodenum and was suggestive of duodenal obstruction. The roentgenologists requested another roentgenogram after gastric lavage. It was felt, however, that since the indications were so strongly in favor of surgical exploration, the patient should be prepared for operation without further investigative effort. On July 24, 1943, an upper right rectus incision was made with the expectation of finding an obstructing lesion, probably a carcinoma, at or near the pylorus.

A subacute ulcer measuring 1.5 cm. was situated on the lesser curvature of the stomach just above the pyloric ring. In addition, the neighboring portion of the upper gastrointestinal tract was hugely dilated. At first it was difficult to determine whether the patient had a tremendously distended hourglass type of stomach secondary to the ulcer, or whether he was suffering from chronic obstruction of the first portion of the duodenum. Further exploration, however, disclosed the typical findings of annular pancreas with



FIG. 4.—Tissue removed at operation. Arrows indicate the large gastric ulcer and the enormously dilated duodenum.

an obstructing band of pancreatic tissue completely surrounding the descending portion of the duodenum.

Partial gastrectomy was performed with removal of the distal half of the stomach and the upper 8 cm. of dilated duodenum (Fig. 4). Gastrointestinal continuity was restored by means of an anterior Balfour-Polya anastomosis.

The patient made a remarkably uneventful recovery, his highest temperature was 100.2° F. on the day after operation, and he was asymptomatic when dismissed from the hospital on August 7, 1943, the fourteenth post-operative day. On October 21, 1943, he wrote to say that he was making good progress and was acceding to the surgeon's request that he refrain from strenuous activity for several months by "not husking any corn for this year."

Of the 11 cases of annular pancreas in which the patients have undergone operation, this is the first in which gastric resection has been performed. This procedure was indicated in this instance because of the accompanying gastric ulcer which fortunately proved to be benign.

In the 10 surgical cases previously reported, treatment consisted of either a short-circuiting operation in the form of gastro-enterostomy, or of more direct relief of the obstruction by the division or resection of the band itself. Lehman, in reviewing the therapeutic indications, favored the direct attack on the ring, although he felt that the evidence was too meager to warrant a definite opinion. The disturbance, however, is a benign, mechanical one, and it seems logical that it should respond to any method which successfully relieves the obstruction.

Pancreatic Heterotopia.—Pancreatic heterotopia is defined as being the presence of pancreatic tissue outside its usual or habitual location and without anatomic relation either of continuity or of vascularization with the pancreas proper.

TABLE I
SUMMARY OF ALL RECORDED CASES *†

Location	War- thin, 1904	Horg- an, 1921	Simp- son, 1927	Hunt and Bone- Steel, 1934	Poppi, 1935	Faust and Mud- gett, 1940	Barbosa and others, 1944 ‡		Total	Per cent
							From litera- ture, March 1944	Auth- ors' cases		
Wall of stomach.....	14	8	25	12	21	15	12	13	120	25.5
Wall of duodenum.....	10	4	14	12	44	21	15	10	130	27.7
Wall of jejunum.....	13	1	10	3	20	8	4	4	75	15.9
Wall of ileum.....	1	1	2	0	6	3	0	0	13	2.8
Diverticulum of stomach.....	1	0	2	0	0	0	1	1	5	1.1
Diverticulum of duodenum.....	0	2	0	1	2	2	5	1	13	2.8
Diverticulum of jejunum.....	0	0	0	0	1	0	0	1	2	0.4
Diverticulum of ileum.....	2	3	4	4	0	0	0	1	14	3.0
Meckel's diverticulum.....	3	1	6	3	0	7	3	2	25	5.3
Umbilical fistula.....	1	0	0	0	0	0	1	1	3	0.6
Mesentery.....	1	0	0	0	2	0	1	0	4	0.8
Omentum (gastrohepatic, gastro- colic, gastrosplenic).....	1	0	0	0	4	0	1	2	8	1.7
Spleen.....	0	0	0	0	1	0	1	0	2	0.4
Splenic capsule.....	0	1	2	0	0	0	0	0	3	0.6
Gallbladder.....	0	0	1	1	1	0	2	1	6	1.3
Cystic duct.....	0	0	0	0	1	0	0	0	1	0.2
Common duct.....	0	0	0	0	0	0	0	2	2	0.4
Liver.....	0	0	0	0	0	0	1	0	1	0.2
Transverse mesocolon.....	0	0	0	0	1	0	0	1	2	0.4
Near pancreas.....	0	0	0	0	0	0	3	0	3	0.6
Mediastinal teratomatous cyst.....	0	0	0	0	1	0	0	1	2	0.4
Miscellaneous.....	2	1	1	0	21	2	10	0	37	7.9
Total cases.....	49	34	67	36	126	58	60	41	471	100
Individual contribution.....	2	2	1	1	3	1	101	41		

* Branch and Gross in 1935 reported 24 cases of their own, besides an additional 10 from the literature.

† From Barbosa, J. J. deC., Dockerty, M. B. and Waugh, J. M.: *Surg., Gynec. & Obst.*, 82: 527, 1946.

‡ Excluding 41 surgical cases of pancreatic heterotopia without microscopic confirmation.

In a complete review of the literature by Barbosa and myself it was found that up to 1944 there had been approximately 430 cases of this condition. To these were added 41 authenticated cases from the Mayo Clinic, making a total of 471 reported to that date.

One hypothesis of the origin of pancreatic heterotopia is that held by Horgan. He expressed the opinion that before coalescence of the two anlagen takes place during circumrotation of the posterior and anterior pancreatic anlagen, when the body of the pancreas migrates upward, the branching ducts, as a result of the organs being packed together, come into contact with the mesentery or with the walls of the stomach or intestine growing in the opposite direction. They become engrafted on these because of noninflammatory adhesions of fetal life. Later, during the growth and movements of the pancreas, the attached part is pulled off and may continue to live incorporated as a graft in the gastric, duodenal or intestinal wall or mesentery.

The incidence of pancreatic heterotopia at necropsy was found by Derbyshire to be 1.7 per cent in 2,785 examinations at the Mayo Clinic. It has been noted approximately once in each 500 operations on the upper portion of the abdomen at the same clinic. This anomaly has been noted in all age groups, but there is a higher incidence of surgical cases in the fourth, fifth and sixth decades of life than in other age periods. The duodenum (27.7 per cent), stomach (25.5 per cent) and jejunum (15.9 per cent) account for the location of the aberrant tissue



FIG. 5.—Mass of heterotopic pancreatic tissue measuring 3.5 by 3 by 1.5 cm. on the lesser curvature and posterior wall of the stomach giving a roentgenologic image of an ovoid mass, in midportion of stomach; its malignant nature could not be excluded roentgenologically.

in 69 per cent of the cases. Table 1 summarizes the location in all recorded cases.

Heterotopic pancreatic tissue usually presents itself as a single, firm and, when visible, light yellowish or white, opaque, lobulated, round or irregular node with granular surface. In the majority of cases the mass is single and its diameter usually varies from 1 to 4 cm.

The histologic picture of heterotopic pancreatic tissue is frequently the same as that of the pancreas itself. The commonest histologic location of heterotopic pancreatic tissue is in the submucosa alone. There frequently is intermuscular infiltration. In the vast majority of cases there is histologic evidence of acinar function. There is no apparent change in the results of analysis of gastric contents associated with pancreatic heterotopia.

Hypoglycemia and hyperinsulinism have been observed in association with heterotopic pancreatic tissue presenting both benign and malignant change in its insular portion. If exploration is being carried out in a case of hypoglycemia associated with definite "Whipple's essential triad," before palpating the pancreas the surgeon should first search for heterotopic pancreatic tissue in its commonest locations and also in the unusual sites that are capable of exploration. Both adenomas

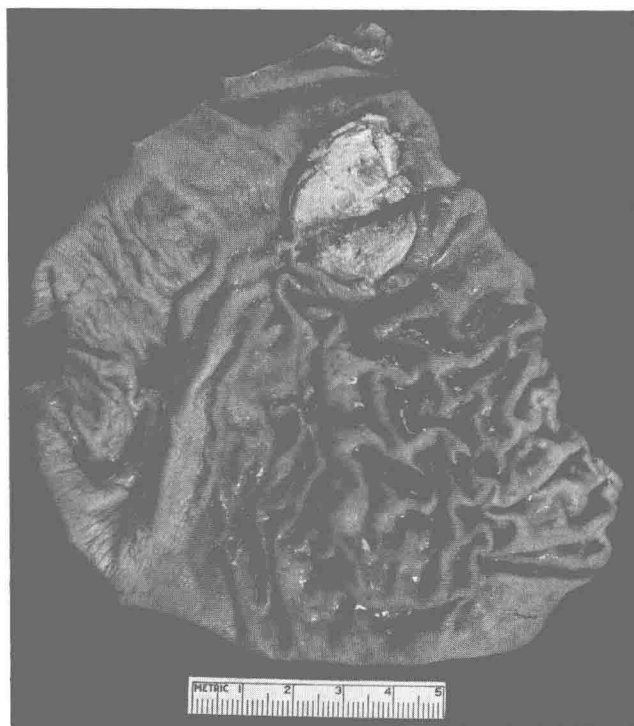


FIG. 6.—Mass of heterotopic pancreatic tissue measuring 3.5 by 3 by 1.5 cm. on the lesser curvature and posterior wall of the stomach. The patient gave a history simulating that of duodenal ulcer and a loss of weight. The tumor was mistaken clinically, roentgenologically, and at operation for an adenocarcinoma of the stomach. The tumor had been sectioned for examination when this picture was taken.

and adenocarcinomas of islet cell type may be present without clinical evidence of hypoglycemia.

Heterotopic pancreatic tissue presents the same pathologic changes as the pancreas itself. In many cases the ducts are found to be dilated. Malignant change is more likely to take place in heterotopic pancreatic tissue than in the pancreas proper. Pancreatic heterotopia may be the cause of several types of pathologic changes in the adjacent tissues; namely, fat necrosis, inflammation, ulceration, hemorrhage, necrosis and formation of a diverticulum.

In a high percentage of surgical cases of pancreatic heterotopia (61 per cent of the cases at the Mayo Clinic), heterotopia is found to be of clinical significance. The location is usually gastric or duodenal. Some of the rare adenocarcinomas of the duodenum may have had their origin in heterotopic pancreatic tissue either in the ampulla of Vater or in the papilla of Santorini. The syndromes presented by pancreatic heterotopia are generally those of gastric or duodenal ulceration, cholecystic disease or indeterminate digestive symptoms (Figs. 5 to 8).

SURGICAL TREATMENT.—There are two circumstances in which pancreatic heterotopia may be found at exploration: it is either causative of symptoms or it is only an incidental finding. In Table 2 are listed the operative procedures performed in 25 cases of the Mayo Clinic