

Invited Lectures

**The Superlative Results of Pylorus Preserving
Pancreaticoduodenectomy for Severe
Complications of Chronic
Pancreatitis**

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1. Introduction

Chronic pancreatitis can result in intermittent or continuous abdominal pain. When this pain is caused by severe and sometimes life-threatening sequelae of chronic pancreatitis, a surgical intervention is usually required. Frequently the problem is located in the head of the pancreas. Examples are the expanding pseudocyst in the head with or without contained or leaking arteriovenous fistula; a pancreatic duct blow-out with pancreatic juice penetrating into the pleural cavity, lesser sac, retroperitoneum, or leaves of omentum; or the giant pseudotumor of calcified fibrosis with bile duct, pancreatic duct, and/or duodenal obstruction.

The purpose of this paper is to analyze the clinical indications for removal of the head of the pancreas in patients with severe complications of chronic pancreatitis. Several methods can be utilized to remove the pancreatic head. These procedures include pancreaticoduodenectomy with hemigastrectomy¹⁾, pancreaticoduodenectomy with preservation of the pylorus²⁾, excision of only the pancreatic head with duodenal and common bile duct preservation³⁾, or resection of just the ventral pancreatic head⁴⁾. This report examines the mortality and morbidity, plus the short and long-term results of the author's preferred method to excise the pancreatic head in patients with severe complications of chronic pancreatitis, i.e., pancreaticoduodenectomy with pylorus preservation (PDPP).

The surgical treatment of chronic pancreatitis can obtain safe and superlative relief of sequelae of these severe complications only with the support of the rapidly progressing technologies of therapeutic endoscopy, interventional radiology, and anesthesiology. Therefore, only the last six years of experience with PDPP for chronic pancreatitis will be reviewed in the personal series of the author. Utilizing modern diagnostic and therapeutic techniques combined with proper patient selection, the procedure of PDPP results in solution of these severe problems and the termination of the associated abdominal pain. With PDPP every patient in this series obtained pain relief with essentially no gastrointestinal sequelae. The mortality rate of PDPP in this series was zero.

2. Materials and Methods

1) Technique of Preserving a Functioning Pylorus

Instead of antrectomy or hemigastrectomy during pancreaticoduodenectomy (Whipple's procedure), the pylorus is widely dissected free of the hepatoduodenal ligament (**Fig. 1**). The following blood vessels to the pylorus are divided at their origins away from the pylorus: the right gastric artery (if present) in the hepatoduodenal ligament at the superior pancreatic border and the right gastroepiploic artery and vein at the inferior border of the pancreas. With this wide dissection technique the neurovascular supply to the pylorus is protected and preserved. Dissection of the duodenal bulb is continued until the area where the first and second parts of duodenum join. This area is also where the duodenum and pancreas merge, forming an "angle" in **Fig. 1**. Many tiny shared blood vessels between pancreas and duodenum are observed at this point. About 5 cm of duodenum will have been freed, and the gastrointestinal anastomosis (GIA) stapling device is used to divide the

Fig. 1 The dashed lines indicate the area of the pancreas, duodenum (parts 2, 3, and 4), and jejunum resected during the pylorus-preserving Whipple procedure. The stomach has been elevated off the pancreas. Ligation of the right gastric (superior pancreatic border) and right gastroepiploic vessels (inferior pancreatic border) at their origin preserve the vascular arcade on the lesser and greater curvatures of the stomach. An intact neurovascular supply to the pylorus and first portion of the duodenum is mandatory for a functioning pylorus. A vagotomy or history of vagotomy precludes pylorus preservation.

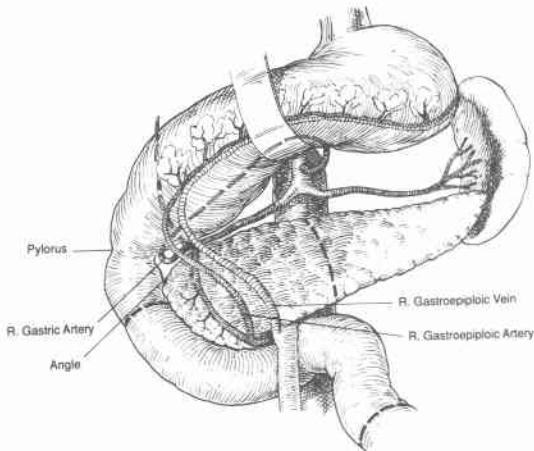
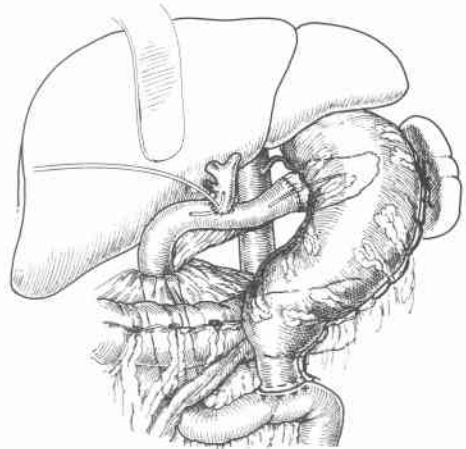


Fig. 2 Reconstruction with retrocolic anastomosis of the pancreatic duct and then bile duct. The pancreatic duct connection should be made with a side-to-side technique if a "chain of lakes" type of ductal dilatation is present. Otherwise an end-to-end mucosa-to-mucosa stented pancreaticojejunostomy is shown. The end-duodenal to side-jejunal anastomosis is made antecolic over the left transverse colon to isolate the duodenal anastomosis from the other anastomoses which have leakage potential and could cause temporary gastric outlet dysfunction.



duodenum at the junction of the first and second parts. Wide dissection of the pylorus and duodenum adjacent to the head of the pancreas makes PDPP less than ideal for en-bloc resection of duodenal or pancreatic cancer, but uniquely suited for chronic pancreatitis. The stomach and stapled-over first part of the duodenum is now mobile and is placed in the left upper quadrant until reconstruction.

The entire vagus nerve supply to the stomach is mandatory to preserve a **functioning** pylorus. A vagotomy or history of vagotomy does not allow preservation of the metering function of the pylorus. After excision of the pancreatic head, remaining duodenum, and distal common bile duct, the anastomoses are positioned to isolate potential leakage of the bile and pancreatic duct connections from the duodenojejunosomy. This maneuver may help to prevent gastric outlet dysfunction. The proximal jejunum is directed toward the pancreatic and bile duct remnants by a retrocolic route and the stomach with preserved pylorus and duodenum are brought antecolic to the left transverse colon, allowing for a remote duodenojejunosomy (**Fig. 2**).

If the chain-of-lakes type ductal dilatation is present in the pancreatic tail, the pancreatic anastomosis may be constructed with a longitudinal side-to-side technique. Many patients will have a duct in the pancreatic remnant with a diameter of 2–3 mm because the pain problem is not due to complete pancreatic ductal obstruction, but is associated with an expanding or leaking pseudocyst or arteriovenous fistula in the head. The small pancreatic duct is reconstructed with an end-to-end mucosa-to-mucosa pancreaticojejunostomy as illustrated in **Fig. 2** and **3**. A 3, 4, or 5 French polytetrafluoroethylene radio-dense stent is utilized that has multiple holes throughout the stent (Wilson-Cook Medical, Inc. Winston-Salem, North Carolina, USA). The stent aids in exact placement of mucosa-to-mucosa sutures.

2) Patient Data

Between January 1986 and February 1992, nineteen patients with chronic pancreatitis have required excision of the head of the pancreas. One of these patients (LC) had previously undergone a vagotomy and antrectomy and, therefore, underwent standard pancreaticoduodenectomy. The remaining 18 patients had their

Fig. 3 The proximal jejunum has previously been divided from the surgical specimen with the GIA stapling device (U.S. Surgical Corp). A staple is removed from the middle of the staple line (left side of figure) and an end-to-end mucosa-to-mucosa pancreaticojejunostomy with 5—0 Maxon (Davis and Geck, Inc). A polytetrafluoroethylene 3, 4, or 5 French radio-dense stent (Wilson-Cook Medical, Inc.) is attached to the anastomosis with absorbable suture. The outer layer is completed with 3—0 silk providing a seromuscular envelope to prevent pancreatic fluid leakage. (From Ref. 11)

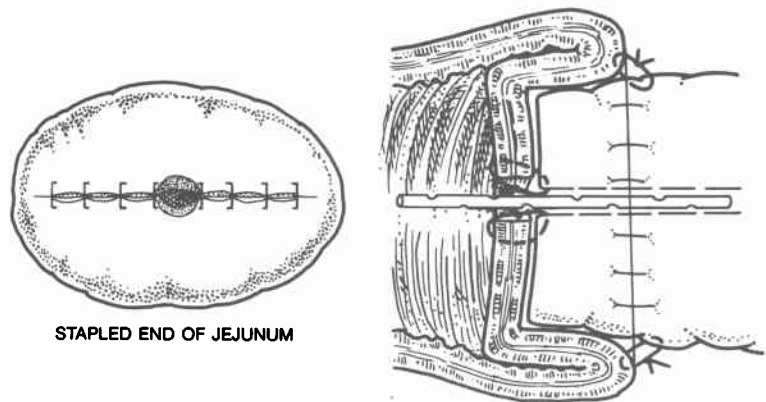


Fig. 4 The characteristics of 19 patients showed that younger men with alcohol induced chronic pancreatitis were frequent. Also, the glands were chronically involved with the majority calcified. Abdominal pain was the most common reason for operation. PRE PAN OP=previous pancreatic operation. GOO=preoperative gastric outlet obstruction.

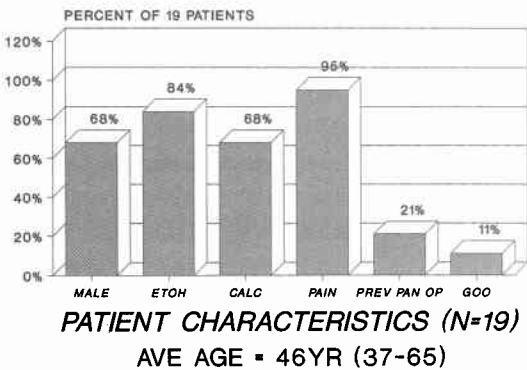
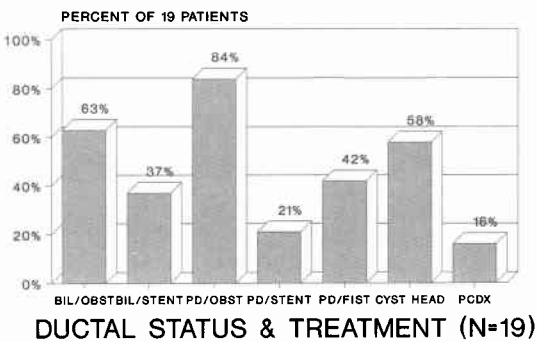


Fig. 5 Every patient underwent ERCP and most demonstrated biliary (BIL/OBST) and/or pancreatic duct (PD/OBST) obstruction. BIL/STENT=biliary stent. PD/STENT=endoscopic transpapillary pancreatic stent. FIST=PD blow-out or cutaneous fistula. CYST HEAD=one or more pseudocysts in or around the head. PCDX=percutaneous drainage preoperative.



pylorus and first part of the duodenum preserved during the pancreaticoduodenectomy (PDPP). Patient characteristics are illustrated in Fig. 4 while the operative status of the bile duct, pancreatic duct, and pancreatic head is shown in Fig. 5. All patients were studied with an endoscopic retrograde cholangiopancreatogram (ERCP) and computed tomography (CT) scans and some received preoperative endoscopic placement of bile duct or pancreatic duct stents. Percutaneous drainage of pancreatic fluid collections was also utilized. Visceral arteriography with portal venous phase was obtained in 18 patients. The importance of understanding the frequent presence of hepatic artery anomalies under the pancreatic head and their significance to prevent biliary fistula cannot be overemphasized when the Whipple procedure is performed for any disease⁵.

Fig. 6 Results of superior mesenteric plus celiac arteriography with portal venous phase—the majority were abnormal. SPL V. THR=splenic vein thrombosis. PV-COMPR=portal vein compression. AV-FIST=arteriovenous fistula. HEP ART ANOM=hepatic artery anomaly.

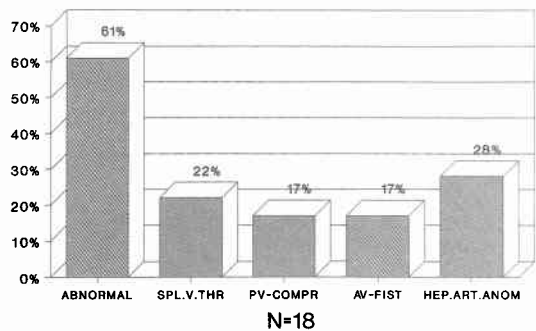
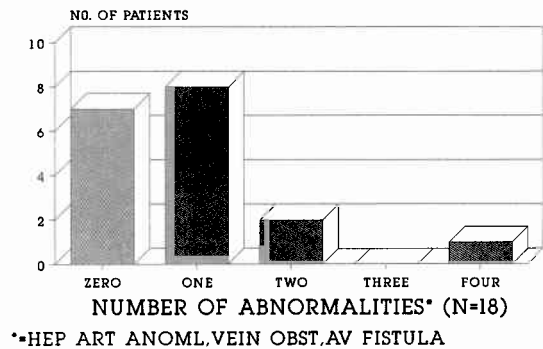


Fig. 7 Three of 18 patients had more than one abnormality. See legend for Fig. 6.



When chronic pancreatitis is present, additional vital information is frequently obtained. Sixty-one percent of these cases showed an abnormality (Fig. 6), with 17% having more than one abnormality (Fig. 7). Examples are pseudoaneurysm or arteriovenous fistula in the mesenteric vessels around the pancreas, clotted splenic vein, thrombosed or compressed portal vein with venous collaterals, or hepatic artery anomalies like the replaced right hepatic artery coursing under the pancreatic head.

3) Case Histories

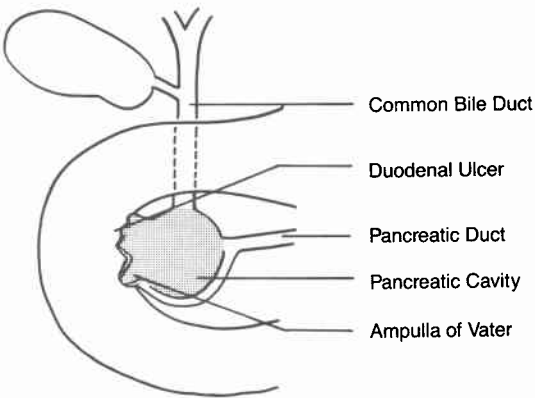
A overview of severe complications requiring excision of the pancreatic head in these patients is listed in **Table 1**. More specific details are presented below regarding the events leading to resection in five selected cases.

(1) RR—This hard-working gentleman had a long history of heavy alcohol use. After a four-month history of right upper quadrant abdominal pain radiating to the back, he was hospitalized for sepsis, jaundice, and abdominal bloating. An arteriogram showed a hypervascular mass in the head of the pancreas thought to be an endocrine tumor. Endoscopy showed a large duodenal ulcer just proximal to the ampulla of Vater. An endoscopic retrograde cholangiopancreatogram (ERCP) showed a communication between the pancreatic duct and common bile duct through a 3 cm cavity in the pancreatic head. Both alkaline phosphatase and transaminase levels were greater than ten times elevated. During his PDPP pancreatic resection, a cloaca-like cavity⁶⁾ was found inside the

Table 1 Reason for resection (N =19)

- 5 Expanding pseudocyst (s) in head-pain
 - 4-Pancreatic duct blowout seen by ERCP
 - 3-Arteriovenous fistula
 - 3-Biliary obstruction
 - 1-Pleural fistula
 - 6 Multiple pseudocysts in head-pain
 - 4-Pancreatic & bile duct obst.
 - 3-Pancreatic duct blowout
 - 2-“Pseudotumors” 8 cm & 12 cm
 - 5 Biliary & pancreatic duct obst-pain
 - 3-Diffuse calcified & enlarged head
 - 2-Duodenal obstruction
 - 2-Pancreatic cutaneous fistula
 - 3 Pancreatic duct obstruction-pain
 - 3-Diffuse calcified & enlarged head

Fig. 8 Schematic summary of the pancreaticobiliary “cloaca-like” chamber in patient RR as obtained from preoperative studies and the surgical specimen (from [6]).



pancreas just above the junction of the common bile duct and the pancreatic duct. This cavity communicated freely with both ducts (**Fig. 8**). The cavity had enlarged to cause local necrosis of the duodenum (as seen by the duodenal ulcer). Bile was present in the pancreatic duct when the pancreas was divided over the portal vein. Histologic examination of the resected specimen showed the intense inflammation to be benign. A 14-hour PDPP Whipple procedure with 2300 ml blood loss was required to resolve the problem. Postoperative ventilator dependence occurred because of ARDS, however, he made a good recovery. No gastrointestinal or endocrine sequelae are present 6 years postoperative.

(2) LC—Had a long history of alcohol-related pancreatitis and recent abdominal pain with biliary obstruction. During a prior admission for abdominal pain, he had undergone embolization of a superior mesenteric artery to portal vein fistula within the wall of a pseudocyst. The 3 cm necrotic cyst was located within the head of the pancreas on the right side of the portal vein. Resolution of abdominal pain led to discharge, but six months later he was readmitted for increasing abdominal pain, jaundice, nausea and vomiting. A percutaneous transhepatic biliary stent was placed. An arteriogram showed absence of mesenteric-portal fistula. CT scan showed persistent pseudocyst. The abdominal pain had to be managed with a chronic epidural catheter. After total parenteral nutrition for ten days, the patient underwent standard pancreaticoduodenectomy (past history of antrectomy). The medial wall of the pseudocyst was the portal vein. An 11-hour Whipple procedure with 2800 ml blood loss was required to solve the problem. Postoperative abscess around the pancreatic anastomosis required percutaneous drainage. No pain or gastrointestinal sequelae are present 4 years postoperative. He began using 5 units/day of insulin one year postoperative.

(3) RS—A long history of alcohol use resulted in an enlarged pancreatic head with multiple calcifications. Workup for abdominal pain and shortness of breath revealed an amylase rich pleural effusion and a contrast enhancing pseudocyst in the head (**Fig. 9**). ERCP showed a PD blow-out filling the cyst and another blow-out communicating with the hepatoduodenal ligament (**Fig. 10**). An arteriogram showed a clotted portal vein and

Fig. 9 A contrast enhancing CT scan of patient RS showed a calcified head with pseudocyst (arrow) plus a contained contrast enhancing area which was shown to be an arteriovenous fistula (see **Fig. 11**).

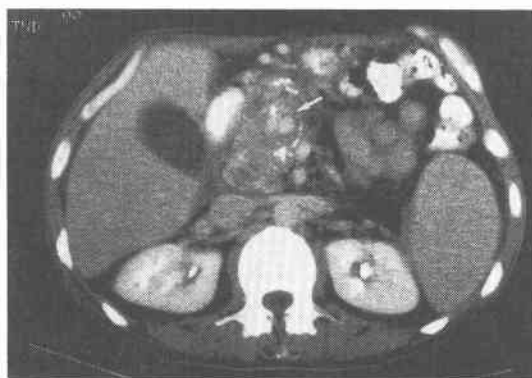


Fig. 10 An ERCP of patient RS shows leaking contrast from a pancreatic ductal blow-out (upper long arrow). One linear collection (short arrow) is shown lateral to a dilated pancreatic duct. Another crescent-shaped collection (open arrow) is seen under the pancreatic duct that partially fills the superior portion of the pseudocyst seen in **Fig. 9**. The pseudocyst is displacing the dilated main pancreatic duct upward and laterally.

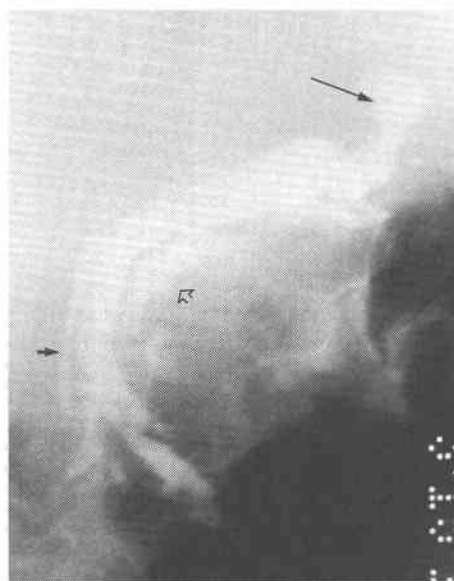


Fig. 11 An arteriogram of patient RS shows an arteriovenous fistula (arrow) off the gastroduodenal artery. This A-V fistula was in the wall of the expanding pseudocyst.

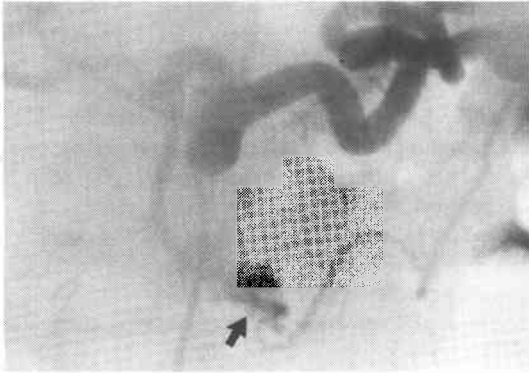


Fig. 12 A replaced right hepatic artery in patient RS that passed underneath the pancreatic head and bile duct as it coursed from the superior mesenteric artery. An injection catheter is in place at the origin of the superior mesenteric artery.

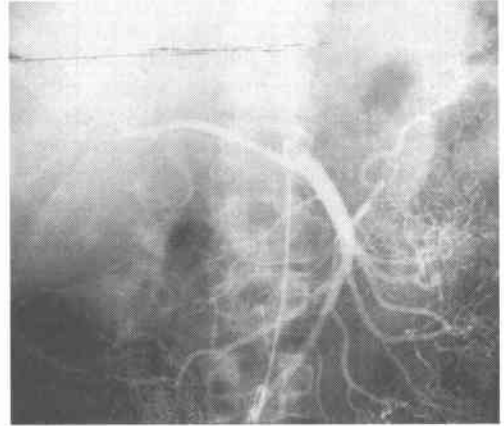
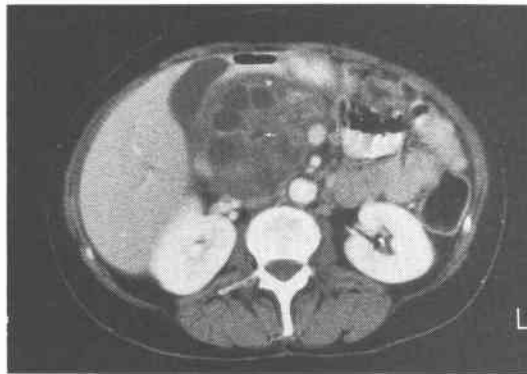


Fig. 13 A contrast enhancing CT scan of patient VA showed a 10×12 cm "pseudotumor" in the head of the pancreas. Multiple pseudocysts are present throughout the head while the normalized CBD is displaced to the center of the head (arrow).



splenic vein plus an arteriovenous fistula off the gastroduodenal artery in the wall of the pseudocyst (**Fig. 11**). A replaced right hepatic artery was seen from the superior mesenteric artery (**Fig. 12**). A 19-hour PDPP procedure with 10,000 ml blood loss was required to resolve the problem. Tracheostomy was necessary for 30 days of ventilator dependence because of ARDS and pseudomonas pneumonia. No pain, gastrointestinal, or endocrine sequelae are present one year and eleven months postoperative.

(4) VA—Developed abdominal pain and a 10×12 cm mass in the pancreatic head (**Fig. 13**) after many years of three drinks of alcohol per day. The mass contained many 1 mm to 2 cm pseudocysts. Both bile and pancreatic ducts were strictured. An 11-hour PDPP Whipple procedure with 1400 ml blood loss solved the problem. Pathology showed intense fibromatosis throughout the mass, which was the entire head of the pancreas. The giant "pseudotumor" contained multiple cystic spaces that did not connect to the pancreatic duct,

as will be illustrated in the next case. No pain gastrointestinal, or endocrine sequelae are present one year and seven months postoperative. Her sister (JS) developed the same findings after a similar clinical history. A PDPP solved the problem and she is symptom free at three months postoperative.

(5) WM—A 65-year-old man who drank heavily 40 years ago during military duty developed increasingly frequent abdominal pain. ERCP showed a blow-out of the pancreatic duct dorsally between the portal vein and aorta connecting to a 2 cm pseudocyst. An 8-hour PDPP Whipple procedure with 1100 ml blood loss solved the problem. A wound infection developed on the seventh postoperative day. No pain or gastrointestinal sequelae are present one year and two months postoperative. Preoperatively he took high doses of an oral hyperglycemic drug. Now he takes the lowest dose possible.

3. Results

1) Short Term

The results are divided into the following groups: "ALL" operations combined, just the "Whipple", or just the "TOTAL" pancreatectomy subgroup. Short term operative results are presented (Table 2) in regards to the length of operation, estimated blood loss, intraoperative or subsequent need for blood transfusion, use of an epidural catheter during the operation and postoperatively, and the 30-day hospital mortality rate.

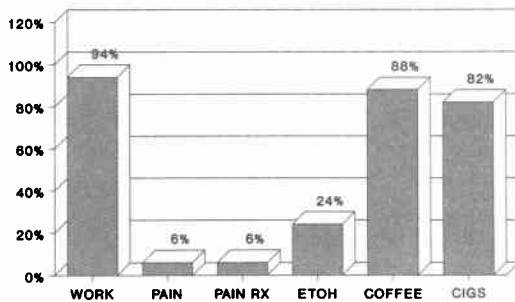
Morbidity during a 30 day postoperative period was seen in nine of nineteen patients. The most common complication (21%) resulting in delay of hospital discharge was gastric outlet dysfunction (oral intake not resumed by 14 days postoperative). This delay was seen in four patients (PDPP Whipple=2, standard Whipple=1 (patient LC), total pancreatectomy=1). All were associated with a retrogastric abscess that required percutaneous drainage. Elevated amylase was found in each abscess after a Whipple. Within several days after drainage the gastric outlet dysfunction resolved. Drainage was temporary and eliminated the abscess; pancreatic fistula did not result. Two patients developed adult respiratory distress syndrome and ventilator dependence for ten and thirty postoperative days. There was one wound infection. No instances of new diabetes were observed during the postoperative hospital stay. One patient was readmitted on the 13th postoperative day for diabetic ketoacidosis. He was a diabetic preoperatively and was discharged prematurely after surgery. Finally, one patient developed primary common bile stones 6 weeks postoperative due to the use of absorbable sutures with delayed absorption time. The stones and sutures were removed endoscopically.

2) Long Term

Long-term results are meaningful after the patient has resumed regular physical activity and diet. This stage has occurred in all patients by three months. One patient died at three months postoperative (suicide). Seventeen patients were over three months postoperative for an average follow-up of 27 months (3—72). All patients were interviewed. Physical activity and habits are shown in Fig. 14. Only one of these patients had not returned to full activity, work, or school. This was the patient readmitted with diabetic ketoacidosis. His main reason for not returning to full activity was severe morning diarrhea not related to eating and despite oral enzyme replacement. He was undergoing workup for a colonic etiology of diarrhea. He also indicated that his preoperative pain was markedly improved, but had occasional right upper quadrant pain which required an oral narcotic analgesic. Almost a quarter of these successfully treated patients had resumed alcohol intake, but none drank to excess. Almost all continued coffee and tobacco use which is so characteristic to these patients with a history of alcohol abuse.

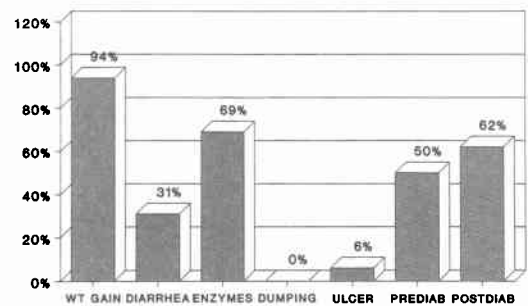
Gastrointestinal, exocrine, and endocrine function status is shown in Fig. 15 for just the 16 patients with pylorus preservation and over 3 months of follow-up. Every patient indicated they were eating from "everything" to "no problem". All but one patient had regained their preoperative weight level, but he was not taking oral enzyme replacement. Two complained of being overweight. The one patient with previous antrectomy (LC) is four years postoperative and is not included in Fig. 15. He could not regain his usual weight of 127 lbs from his 107 lbs but he was not taking oral enzymes. Four patients (25%) indicated diarrhea would occur when not taking pancreatic enzyme supplements. Two patients indicated they had postprandial diarrhea for six months and one year postoperatively. Each patient's diarrhea had resolved. One patient described dumping syndrome prevented by avoiding a high-carbohydrate meal, particularly milkshakes or chocolate. This resolved one year postoperative. One patient developed a marginal ulcer nine months postoperative. He had a history of peptic ulcer disease and was treated with omeprazole. Diabetes was present in eight (50%) patients (44%) preoperatively and ten patients (62%) postoperative at the average follow-up time of 26 months. Both of the patients developing diabetes

Fig. 14 Long term follow-up (greater than 3 months postoperative) was available in all of the 17 eligible patients who had undergone PDPP (N=16) or standard Whipple (N=1). WORK=return to physical activity, school, or employment. PAIN RX=taking any pain medication for abdominal pain. ETOH=use of any alcoholic beverage, however, none of these patients drank to excess. CIGS=cigarette use.



N=17: PDPP=16; STD WHIPPLE= 1

Fig. 15 Long term gastrointestinal (GI), exocrine, and endocrine function in only the PDPP patients of Fig. 14. Stable WT=able to regain and maintain preoperative weight. ULCER=marginal ulcer. DIARRHEA=any loose bowel movements on a regular basis. ENZYMES=oral pancreatic exocrine enzyme replacement. PREDIAB and POSTDIAB=pre or postoperative diabetes.



FOLLOW-UP = 26MO(3-72MO); N=16

postoperatively did so over one year after surgery and had shrunken calcified pancreatic remnants. Every patient undergoing total PDPP was diabetic preoperative.

4. Discussion

Excision of the head of the pancreas was required in these patients for abdominal pain resulting from one of two situations: progressive disease in the pancreatic head (pseudocyst, duct blow out, AV fistula), or significant fibrosis in the pancreatic head resulting in an enlarged, usually extensively calcified head with the pancreatic duct obstructed with or without biliary and/or duodenal obstruction.

These cases emphasize that the head of the pancreas was the pacemaker of chronic pancreatitis. A continuous smoldering inflammatory process within the head of the gland will result in persistent symptoms even after major ductal decompression procedures. The latter procedure is incapable of draining the multiple ductal connections within the head of the gland, and therefore, cannot interrupt the process. The current report indicates that excision of the head of the gland relieved symptoms in all patients, was associated with zero mortality, and little permanent gastrointestinal dysfunction. Pain relief was immediate. In addition, PDPP solved distressing clinical problems of sepsis, jaundice, or dependence on parenteral nutrition. No patient reported attacks of recurrent pancreatitis or required reoperation for pancreas related problems.

Previous experience with pain relief following a Whipple procedure has been superior if patients abstained from alcohol abuse⁷. In that study the patients also has statistically superior results (as compared to pseudocyst drainage) with fewer readmissions for recurrent pancreatitis. Follow-up in the latter study was 3.2 years and 2.3 years in the current series.

Beger and colleagues³ reported a 14% recurrent pancreatitis rate after a median follow-up of 24 months following duodenal and common bile duct preservation plus excision of only the pancreatic head. Partial or complete relief of chronic pain was observed in 93%. As the advantages of this operation approach those of PDPP future randomized comparison studies should be considered. The Beger procedure preserves the pylorus, entire duodenum, and common bile duct removing almost all of the pancreatic head. The sequelae of sacrificing the common bile duct and most of the duodenum during PDPP (as compared to the Beger procedure) were assessed by examining the 27 month follow-up for the PDPP patients. They had not experienced episodes of cholangitis, biliary fistula, dumping, or postprandial diarrhea.

Those patients not developing gastric outlet dysfunction resumed a diet on an average of the 11th postoperative day. Gastric outlet dysfunction developed in four of the 19 patients: three with PDPP and the only

patient who had undergone a standard Whipple. The three PDPP patients were able to resume a regular diet 20 days postoperatively. In these PDPP patients with gastric outlet dysfunction, a CT scan showed a retrogastric or peripancreaticojejunostomy fluid collection, which was percutaneously drained. All collections were associated with an elevated amylase. All patients began eating within several days of percutaneous drainage. None developed pancreatic fistula. The remaining gastric outlet obstruction patient (LC) had prior antrectomy and a similar CT finding of peripancreatic fluid collection. Effective drainage resulted after repositioning a nearby drain on the 22nd postoperative day, however, he did not resume a diet until the 36th postoperative day. Therefore, gastric outlet dysfunction after PDPP in these patients is not attributable to preserving the pylorus, but rather to a subclinical inflammation from pancreatic juice.

Marginal ulceration was seen in one PDPP patient (6%) at nine months postoperative. He had a history of peptic ulcer disease. Five years of follow-up may be necessary to assess the incidence of marginal ulceration⁹. It seems fair to state that no higher incidence has been observed after PDPP when compared to standard pancreaticoduodenectomy⁹⁾⁽¹⁰⁾. Antrectomy, therefore, seems unnecessary during the standard Whipple for benign disease since its only role is prevention of marginal ulceration, and antrectomy is accompanied by other gastrointestinal emptying sequelae. Patients with a prior history of peptic ulcer disease should be just as susceptible to acid associated ulceration after PDPP as before this surgery. In this case the advantages and disadvantages of H₂ blockers versus antrectomy should be reconsidered in a patient with peptic ulcer disease.

This series showed a significant morbidity, as with any series of pancreaticoduodenectomy. In contrast to excision of the head for periampullary tumors, the patient with chronic pancreatitis has a marked inflammatory or fibrotic process with frequent portal venous compression or thrombosis. An obligate intraoperative blood loss results. Blood transfusions were therefore, the rule in treating these chronic pancreatitis patients with excisional procedures. The operative difficulty with this inflammatory process is also significant, as demonstrated by the prolonged operating time. However, the major cause of postoperative morbidity was not related directly to chronic pancreatitis-associated inflammation, but rather to pulmonary complications or presence of pancreatic juice in the peritoneal cavity. The latter complication accounts for the increased morbidity with the Whipple as compared to total pancreatectomy.

Utilizing the end-to-end mucosa-to-mucosa PTFE stented anastomosis (described in Fig. 3), the last 6 patients with a pancreatic anastomosis have not leaked or developed an abscess. Using a normal dog pancreas and this stented anastomosis, we observed no leaks in 24 experiments¹¹⁾. The stent facilitates exact placement of mucosa-to-mucosa sutures and probably does not have to remain in place. If the stent remains, the multiperforate PTFE may be best.

In these chronic pancreatitis patients the association of leakage with gastric outlet obstruction is seen in Table 2. The morbidity, return to GI function, and hospital days were all prolonged in the Whipple versus the total pancreatectomy group, primarily due to a minimal anastomotic leak. The use of somatostatin analogue in patients with the Whipple procedure should be considered¹²⁾. The only gastric outlet obstruction seen in the total pancreatectomy group had a fragment of residual pancreatic tail remaining which resulted in a left upper quadrant abscess, gastric outlet obstruction, and marginal ulcer.

The major cause of morbidity was an abdominal abscess near the pancreatic anastomosis with secondary gastric outlet dysfunction. Investigation with CT scanning found peripancreatic fluid collections in all patients

Table 2 Short-term results

	All (N = 19)	Whipple (N = 12)	Total (N = 7)
Time of oper.	10.0HR (7-19)	10.3HR (7-19)	9.4HR (7-15)
EST. blood loss	1616ML (300-10,000)	1938ML (300-10,000)	1064ML (450-2,000)
% Transfused	79%	75%	86%
Units transfused	3.4(0-20)	3.2(0-20)	3.7(0-11)
Epidural catheter	79%	75%	86%
Mortality (30 day)	none	none	none
Morbidity (30 day)	47%	50%	43%
Return gi funct*	12d(8-36)	13d(10-36)	12d(8-18)
Hospital days*	19d(12-68)	21d(12-68)	14d(12-20)

*Excluding the one non-PDPP case

with delayed return to gastrointestinal function. Once the fluid was percutaneously drained, the obstruction resolved. PDPP has been reported to have a high incidence of delayed gastric function¹³⁾, but the only patient in the current series with pancreaticoduodenectomy **without** pylorus preservation also had this problem. The common factor appears to be an inflammatory process (temporary or subclinical leak related to the pancreatic anastomosis) locally irritating the posterior gastric wall.

The pancreatic anastomosis techniques associated with gastric outlet obstruction were reviewed. One side-to-side 8 centimeter pancreaticojejunostomy and two end-to-side pancreaticojejunostomy procedures leaked. The latter two were performed with silicone rubber stents, a technique I have found in the dog pancreas to be associated with a 40% leak rate as compared to no leaks using the Wilson-Cook stent. The stented end-to-end pancreaticojejunostomy in the chronic pancreatitis patients had not leaked.

Advances in anesthesia through the use of epidural catheters have significantly decreased the amount of inhalation anesthetics needed to obtain adequate anesthesia. The epidural catheter is utilized for excellent pain control in the postoperative period, although it may prolong postoperative ileus. Improved postoperative pain control with regional administration of narcotics undoubtedly improves the patients' respiratory function in these chronically debilitated and usually tobacco-smoking individuals. No episodes of persistent atelectasis or pneumonia were seen in these patients. The two pulmonary complications (ARDS) were related to large intravascular volume changes associated with the operative blood loss.

The advances of interventional radiology and therapeutic endoscopy are evident in the case histories of these patients. Preoperatively, three patients underwent percutaneous drainage of pseudocysts while one underwent embolization of an arteriovenous fistula contained within a pseudocyst. Biliary obstruction was seen in 63% and seven of these individuals underwent preoperative biliary stent placements, either endoscopically or trans-hepatically. Pancreatic duct obstruction was common (84%), with four patients having endoscopically placed pancreatic stents. The PD stent allows time for nutritional support while inflammation subsides¹⁴⁾. One patient underwent endoscopic transduodenal decompression of a large pseudocyst, utilizing a pancreatic stent placed from the duodenum through the pancreatic duct in the body of the gland, and the stent allowed resolution of the pseudocyst and ultimate operative management. Four patients required postoperative percutaneous drainage of fluid collections around the pancreatic anastomosis.

Because of significant inflammation, fibrosis, and ductal obliteration or blow-out in the head of the gland, the pathology in these patients resulted in stenosis of the duodenum and/or common bile duct. Even an intrapancreatic cyst disruption into the bile duct resulted in one case. Therefore, a procedure that preserved the duodenum and distal common bile duct was felt not indicated, and PDPP was performed without mortality. In this series, no significant or permanent sequelae from removal of the duodenum or preserving the pylorus were seen, while all patients experienced relief of symptoms.

The concept of preserving portions of the gastrointestinal tract traditionally removed during the standard Whipple procedure deserves attention by pancreatic surgeons. Future studies are required to compare the results of PDPP to the duodenal preserving resection of the head of the pancreas, a procedure which also removes the "pacemaker of pancreatitis".

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