

# Central Pancreatectomy With Pancreaticogastrostomy for Benign Pancreatic Pathology

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Benign lesions of the neck and proximal body of the pancreas pose an interesting surgical challenge. If the lesions are not amenable to simple enucleation, surgeons may be faced with the choice of performing a right-sided resection (pancreaticoduodenectomy) or a left-sided resection (distal pancreatectomy) to include the lesion, resulting in resection of a substantial amount of normal pancreatic parenchyma. Central pancreatic resection has been reported with Roux-en-Y pancreaticojejunostomy reconstruction; however, this interrupts small bowel continuity and obligates an additional anastomosis. We have reviewed our experience with central pancreatectomy with pancreaticogastrostomy (PG) for benign central pancreatic pathology. Between January 1999 and December 2002, 14 central pancreatectomies were performed with PG reconstruction. There were 7 women and 7 men with a mean age of 60.9 years. Five resections were performed for islet cell tumors, three were performed for noninvasive intraductal papillary mucinous neoplasms, two were performed for serous cystadenoma, and one each was performed for a simple cyst, pseudocyst, mucinous metaplasia, and focal chronic pancreatitis. Seven out of 14 patients experienced a total of 10 complications. Pancreatic fistulae manifested by drainage of amylase-rich fluid from the operatively placed drains developed in 5 patients (36%). Reoperation or interventional radiologic procedures were not required in any patient with a fistula. Postoperative follow-up demonstrated 13 out of 14 patients to be alive and well without evidence of pancreatic insufficiency. One patient died at home on postoperative day 57 of cardiac pathology. Central pancreatectomy with PG is a safe and effective procedure that allows for preservation of pancreatic endocrine and exocrine function without disruption of enteric continuity. The complication of pancreatic fistula was managed conservatively via maintenance of operatively placed drains. (*J GASTROINTEST SURG* 2004;8:532-538) © 2004 The Society for Surgery of the Alimentary Tract

KEY WORDS: Benign pancreatic lesions, central pancreatectomy, pancreaticogastrostomy

Central pancreatectomy has recently been described by several authors as an alternative to distal pancreatectomy or pancreaticoduodenectomy for benign lesions of the neck or proximal body of the pancreas.<sup>1-7</sup> This procedure has the advantages of avoiding the morbidity and mortality associated with pancreaticoduodenectomy, preserving splenic function by avoiding the splenectomy that frequently accompanies distal pancreatectomy, and preserving maximal pancreatic endocrine and exocrine function. The vast majority of cases that have been reported in the literature describe pancreatic-enteric reconstruction of the left-sided pancreatic remnant using

a Roux-en-Y limb of jejunum to construct a pancreaticojejunostomy (PJ).

Pancreaticogastrostomy (PG) was reported by Sherwin and Tripodi in a canine model<sup>8</sup> and used clinically by Waugh and Clagett as a means of implanting the pancreatic remnant into the gastrointestinal (GI) tract.<sup>9</sup> Numerous studies have reported the efficacy of PG as an alternative method of reconstruction after pancreaticoduodenectomy.<sup>10-16</sup> In the setting of central pancreatectomy, PG has the advantage of avoiding the disruption of enteric continuity necessary with Roux-en-Y reconstruction and obviating the need for the jejuno-jejunostomy required for

Presented at the Forty-Fourth Annual Meeting of The Society for Surgery of the Alimentary Tract, Orlando, Florida, May 18-21, 2003 (poster presentation).

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Roux-en-Y reconstruction. Here we describe our experience with central pancreatectomy using PG for distal pancreatic reconstruction.

## PATIENTS AND METHODS

Patients who underwent central pancreatic resection with PG reconstruction were identified from departmental and individual surgeon experience. A retrospective review of hospital records was undertaken. The study was approved by the Institutional Review Board for Human Research and complied with Health Insurance Portability and Accountability Act (HIPAA) regulations.

Between January 1999 and December 2002, 14 central pancreatectomies were performed with PG reconstruction. There were 7 women and 7 men with a mean age of 60.9 years (range 37–84 years). Lesions were identified most frequently by CT scan succeeded by magnetic resonance imaging (MRI), endoscopic retrograde cholangiopancreatography (ERCP), endoscopic ultrasound, and transabdominal ultrasound. Five resections were performed for islet cell tumors (three nonfunctional, two insulinomas), three were performed for noninvasive intraductal papillary mucinous neoplasms (two IPMN-adenoma, one borderline), two were performed for serous cystadenoma, and one each was performed for a simple cyst, pancreatic pseudocyst, mucinous metaplasia, and focal chronic pancreatitis (Table 1). Resected lesions exhibited an average diameter of 2.2 cm. Figure 1 demonstrates CT scans from 4 patients with lesions resected via central pancreatectomy. Though central

pancreatectomy was considered possible for all patients preoperatively, the final decision to proceed was made intraoperatively after assessment of anatomy and pathology.

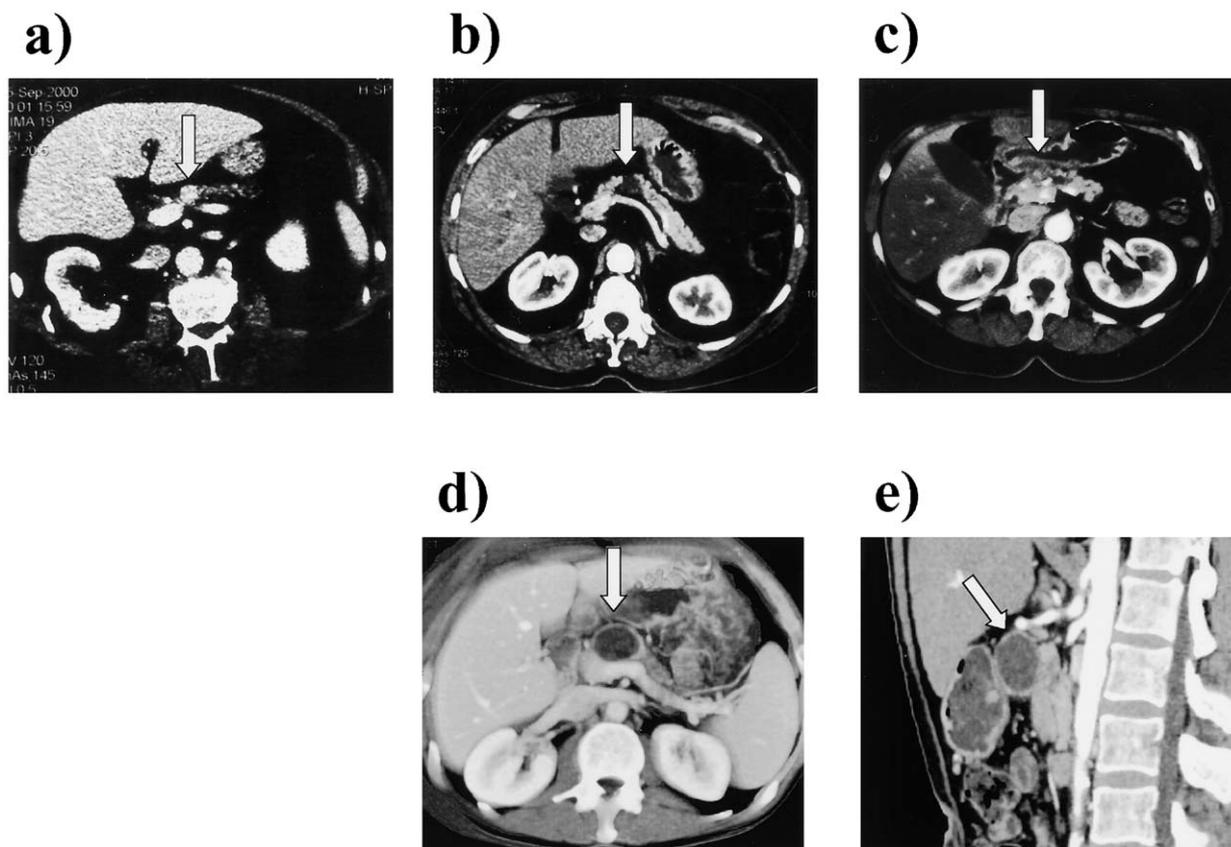
A midline abdominal incision is typically used. The abdomen is explored for synchronous pathology. The lesser sac is entered by dividing the gastrocolic ligament and the stomach is retracted in a cephalad manner. The pancreas is identified and the neck or proximal-body lesion is localized (Fig. 2). If there is any difficulty localizing the lesion, intraoperative ultrasound can be used to locate and define the pathology. The pancreas is elevated off the superior mesenteric vein-portal vein and divided proximally yielding an appropriate proximal margin free from the lesion. The pancreas is dissected out of the retroperitoneum and away from the splenic vein and artery leaving these vessels intact. The pancreas is then divided distal to the lesion, again insuring an appropriate negative margin. The specimen is sent to pathology for margin analysis (Fig. 3, inset).

If the margins are negative and the pathology is confirmed as benign, the proximal pancreatic stump is closed with horizontal mattress sutures. Care is taken to identify and specifically ligate the pancreatic duct. The distal pancreatic remnant is then anastomosed to the posterior wall of the stomach (Fig. 3). In 12 patients the PG anastomosis was constructed in two layers with an outer layer of 3-0 interrupted silk and an inner running layer of 3-0 vicryl. In 2 patients the anastomosis consisted of a single layer of interrupted silk sutures. No pancreatic duct stents were used in any of the patients. Closed suction silastic drains were operatively placed near the PG anastomosis and the pancreatic remnant. The number of drains

**Table 1.** Demographics, symptoms, and pathologic data

Patient	Sex	Age (yrs)	Symptoms	Pathologic diagnosis	Size (cm)
1	F	62	Light-headedness	Islet cell tumor, nonfunctional	1.1
2	M	50	Chronic pancreatitis	Simple cyst	3.5
3	M	65	Indicated during work-up of acute pancreatitis, nonresolving	Pseudocyst	4.0
4	F	77	Nonspecific abdominal pain	Mucinous metaplasia	1.5
5	M	84	Hypoglycemia	Insulinoma	1.5
6	F	51	Epigastric pain	Serous cystadenoma	3.5
7	F	56	Asymptomatic	Islet cell tumor, nonfunctional	2.2
8	F	72	Abdominal pain	IPMN-borderline	2.2
9	M	37	Hypoglycemia	Insulinoma	1.5
10	M	65	Recurrent pancreatitis	Focal chronic pancreatitis	3.0
11	F	63	Asymptomatic	Serous cystadenoma	2.2
12	M	52	Flank/back pain	IPMN-adenoma	2.5
13	F	70	Asymptomatic	IPMN-adenoma	1.4
14	M	48	Mild steatorrhea	Islet cell tumor, nonfunctional	0.8

IPMN = intraductal papillary mucinous neoplasm.



**Fig. 1.** CT scans demonstrating lesions resected via central pancreatectomy. (A) Hypervascular lesion in the neck of the pancreas; pathology: islet cell tumor. (B) Cystic lesion in the mid-body with dilated distal duct; pathology: IPMN. (C) Cystic lesion in the neck of the pancreas; pathology: serous cystadenoma. (D) axial and (E) coronal of a three-dimensional reconstruction CT scan of a cystic lesion of the pancreatic neck; pathology: simple cyst (*arrows* demonstrate lesions).

were placed at the discretion of the operating surgeon. The use of octreotide was also at the discretion of the individual surgeon and quite variable between patients. In recent years octreotide has not been used. Data are given as mean  $\pm$  standard deviation.

## RESULTS

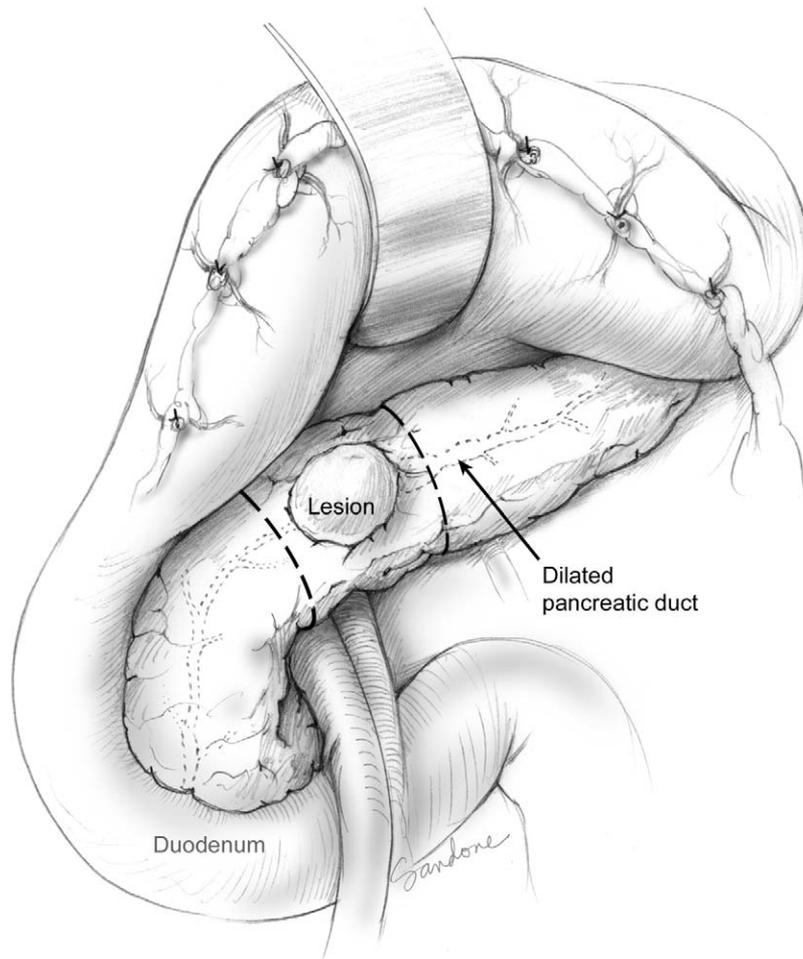
The operative and hospital data are listed in Table 2. The mean operative time was 229 minutes with a mean estimated blood loss of 412 ml. Only 4 patients received red blood cell transfusion. An average of 2 peripancreatic drains were employed (range 1–4) for an average duration of 10.9 days (6.7 days for patients without fistula). The mean postoperative length of hospital stay was 11.1 days (9.9 days for patients without fistula).

Seven patients experienced a total of 10 complications (Table 3). Two patients returned to the operating room (OR). One patient with an upper GI

bleed recognized on the night of surgery was taken back 6 hours postoperatively for suture ligation of a bleeding vessel at the PG. This was approached via an anterior gastrotomy. The second patient returned to the OR on postoperative day 17 for a mechanical small bowel obstruction that occurred as a result of acute herniation of bowel through the midline fascia at a site of fascial dehiscence.

One patient suffered a late postoperative upper GI bleed at the PG (identified on postoperative day 10). This patient had been anticoagulated for a prosthetic heart valve and the bleed was managed with transfusion, reversal of anticoagulation, and endoscopic cauterization. The patient was subsequently discharged, but died from complications of severe cardiac disease on postoperative day 57.

Postoperative pancreatic fistula developed in 5 patients. All fistulae were controlled by the operatively placed drains and required no further intervention. The development of a pancreatic fistula increased the length of hospital stay by 3.5 days (9.9–13.4 days).



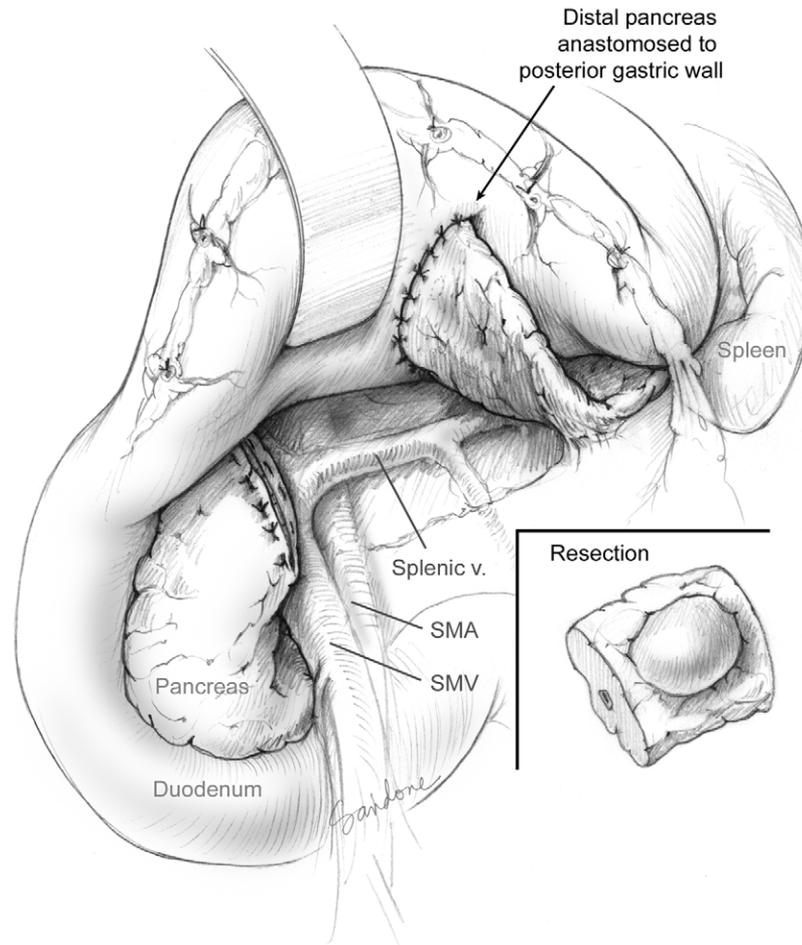
**Fig. 2.** A view of the pancreas with a benign cystic lesion in the neck and proximal body of the pancreas. The gastrocolic ligament has been divided and the stomach retracted in a cephalad manner. The *dashed lines* depict lines of parenchymal transection. A dilated pancreatic duct is illustrated distal to this benign cystic lesion.

All drains were removed and fistulae sealed by postoperative day 30. Only 1 patient experienced a persistent pancreatic leak after drain removal and this patient demonstrated closure of the leak with short duration of intravenous antibiotic, parenteral nutrition, and NPO (nothing by mouth) status.

Other complications included a urinary tract infection in 1 patient and a perioperative cerebrovascular accident in another patient. Postoperative follow-up of 12.3 ( $\pm 12.5$ ) months (range 1–42 months) demonstrated 13 out of 14 patients to be alive and well without evidence of pancreatic endocrine or exocrine insufficiency. At the time of the last follow-up, none of the patients were taking exogenous pancreatic supplements and none of the patients were rendered diabetic by this procedure.

## DISCUSSION

Previous reported series of central pancreatectomy have largely described reconstruction featuring anastomosis of the distal pancreatic remnant to a Roux-en-Y jejunal limb. Between 1995 and 2000 four series from single institutions<sup>1,3,4,5</sup> reported patients who underwent central pancreatic resection for various benign lesions. These series ranged from 10–24 patients and were reconstructed using a Roux-en-Y PJ. Overall complication rates in these series ranged from 13%–40% with no perioperative mortality. In the largest series of central pancreatectomy, Sauvanet and the members of the French Pancreas Club retrospectively reported a multi-institutional collection of 53 central resections, 26 of which were reconstructed via a Roux-en-Y PJ and 25 of which underwent PG



**Fig. 3.** A view of the completed pancreaticogastrostomy (PG) and oversewn proximal pancreatic remnant. The inset depicts the specimen properly oriented and ready to be sent to pathology for diagnosis and margin assessment.

anastomosis (in the remaining 2 patients the pancreatic remnant was oversewn).<sup>2</sup> They reported no appreciable difference in postoperative course or complications, but felt that the PG was a technically easier operation as there was no need to construct

the Roux loop. Their overall complication rate was 41% with 1 postoperative death (2%).

A number of studies have specifically examined the use of PG vs. PJ reconstruction of the distal pancreatic remnant after pancreaticoduodenectomy.<sup>10-12</sup> Both methods have been demonstrated to be safe and well

**Table 2.** Operative/hospital data

Mean operative time	229 minutes ( $\pm 49$ )
Mean estimated blood loss	412 ml ( $\pm 326$ )
Mean number of drains	2 (range 1-4)
Average drain duration	10.9 days ( $\pm 8.5$ )
Without fistula	6.7 days ( $\pm 1.5$ )
With fistula	18.6 days ( $\pm 10.8$ )
Average length of postoperative hospital stay	11.1 days ( $\pm 6.3$ )
Without fistula	9.9 days ( $\pm 5.8$ )
With fistula	13.4 days ( $\pm 7.0$ )
(mean $\pm$ standard deviation)	

**Table 3.** Complications

Patients without complications	7 (50%)
Patients with complications	7 (50%)
Reoperations	2
Pancreatic fistula	5
Upper GI bleed	2
Small bowel obstruction	1
Cerebrovascular accident	1
Urinary tract infection	1

GI = gastrointestinal.

tolerated and there seem to be no considerable differences between PG and PJ both in perioperative complications and long-term outcome. Several authors have suggested that PG may be a superior method of pancreaticoenteric anastomosis after pancreaticoduodenectomy,<sup>13-16</sup> but this has not been supported by prospective randomized study.<sup>10</sup>

In the current retrospective review, endocrine function of the patient was not specifically assessed with oral glucose tolerance tests. Four series have reported the use of oral glucose tolerance testing to postoperatively assess endocrine function in patients after central pancreatectomy.<sup>1-4</sup> New onset diabetes after central pancreatectomy was reported as developing in only 4 out of 100 patients. Two of these patients were determined to have chronic pancreatitis or fibrosis on pathology, likely contributing to their glucose intolerance.<sup>2,4</sup> Diabetes after resection of an excessive amount of pancreatic parenchyma developed in 1 patient. The remaining patient who was rendered diabetic became so after conversion of the central resection to a pancreaticoduodenectomy as a result of a recurrence of an IPMN.<sup>2</sup> No patient in our series exhibited evidence of postoperative endocrine dysfunction, however, our follow-up is relatively short (mean = 12.3 months). Nonetheless, by preserving pancreatic parenchyma on both the right and left sides of the gland, it would be anticipated that central pancreatectomy would be accompanied by a lower risk of diabetes as compared with larger resections such as pancreaticoduodenectomy or distal pancreatectomy. Further, central pancreatectomy seems to be a better solution, when applicable, than distal pancreatectomy, because there is more preservation of both endocrine and exocrine function.

One potential disadvantage of PG after pancreaticoduodenectomy is the possible loss of exocrine function. Pessaux and associates recently demonstrated that even though the vast majority of PG anastomoses maintained patency (68%), evidence of exocrine insufficiency was seen in up to 95% of patients after pancreaticoduodenectomy with PG.<sup>17</sup> Yet, despite these findings, this does not seem to lead to substantial changes in postoperative physiology or quality of life.<sup>18-20</sup> Central pancreatectomy patients most likely preserve adequate exocrine function because the head and uncinate process are left intact with normal exocrine drainage.

By far the most challenging technical complication after pancreatic surgery remains the pancreatic fistula. It is well tolerated if adequately controlled and usually seals with conservative measures (NPO status, parenteral nutrition, octreotide). Pancreatic leaks after pancreaticoduodenectomy have been indicated to occur in 5%–30% of patients, varying based upon

underlying pathology, pancreatic texture, and surgeon experience.<sup>21</sup> This is further complicated by the liberal interpretation of what constitutes a pancreatic fistula, as no standard definition has been universally accepted. Leak rates for distal pancreatectomy may also be as high as 25%.<sup>22-24</sup> Central pancreatectomy, by definition, retains both the oversewn proximal pancreatic remnant (right-sided gland) as well as a distal pancreaticoenteric anastomosis yielding two sources of pancreatic leakage. Fortunately, the risk of fistula does not seem to be strictly additive, but it is likely that leak rates for central pancreatectomy will always exceed rates for single-sided pancreatic resection. In the reported series of central pancreatectomy,<sup>1-7</sup> fistula rates ranged from a low of 4% to a high of 36%.

Upper GI bleeding developed in 2 patients in our series. In the first patient the bleed occurred immediately postoperatively and was controlled with return to the OR and suture ligation. This patient was 1 of 2 that underwent a single layer reconstruction via PG and was believed by the surgeon to have been a technical complication. The second patient demonstrated a delayed onset bleed (postoperative day 10) and carried the additional risk of requiring anticoagulation for a mechanical heart valve. Though difficult to draw meaningful conclusions given the small size of our series, previous studies of PG anastomoses do not predict a higher risk of GI bleed from this method of reconstruction.<sup>10-12</sup>

In this series, none of the patients underwent central resection without confirmation of benign pathology and negative resection margins. Intraoperative frozen section was used to rule out malignancy and confirm negative margin status of the pancreatic remnants (both proximal and distal). For patients with IPMNs this poses a difficult question: is central pancreatectomy appropriate? IPMN has been identified as a premalignant lesion. A number of the series of central pancreatectomy have reported this procedure with patients exhibiting IPMNs.<sup>1-3,5,6</sup> Sauvanet reported that 2 of the 5 patients who underwent central resection for IPMNs demonstrated local recurrence identified within 2 years.<sup>2</sup> In our series, 3 patients demonstrated IPMN on pathology; 2 patients were 70 years or older whereas 1 patient was 52 years of age. Also, two of the IPMNs were identified as adenomas on pathologic review whereas one was identified as borderline. There were no lesions that demonstrated severe dysplasia or carcinoma in situ. Clearly, until more definitive data are seen, the possibility of pancreatic cancer developing in these patients, who remain at risk, will require continued surveillance.<sup>25</sup>

## CONCLUSIONS

Central pancreatectomy with PG is a safe and effective procedure that allows for the preservation of pancreatic endocrine and exocrine function without the disruption of enteric continuity. In our experience, the complication of pancreatic fistula was managed conservatively via maintenance of operatively placed drains and did not require invasive intervention to allow healing.

*We gratefully acknowledge the original artwork in this paper, which was created by Corrine Sandone, M.A. (Assistant Professor, Johns Hopkins School of Medicine, Art as Applied to Medicine).*

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