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# Central pancreatectomy for benign pancreatic lesions

KIMBERLY M. BROWN, MARGO SHOUP, ADAM ABODEELY, PAM HODUL, JOHN J. BREMS & GERARD V. ARANHA

*Department of Surgery, Loyola University Medical Center, Maywood, IL, USA*

**Abstract**

*Introduction*. Traditional resections for pancreatic malignancies include distal pancreatectomy with splenectomy and pancreaticoduodenectomy (PD). Alternative resections for benign pancreatic disease are used to minimize the resection of normal pancreatic and splenic parenchyma. This study describes the use of central pancreatectomy (CP) in 10 patients. *Methods*. A retrospective chart review of all patients undergoing CP between May 1999 and February 2004 was undertaken. *Results*. Ten patients (eight female, two male) underwent CP for benign pancreatic disease. Median age was 59 years (range 21–75). Eight patients presented with abdominal pain, two of whom also had weight loss. One patient each presented with hypoglycemia and as an incidental finding. Median operative time was 255 min (range 160–380 min). Proximal pancreatic remnant was stapled in five and oversewn in five. Distal pancreatic remnant was managed with pancreaticojejunostomy in six patients and pancreatjcogastrostomy in four patients. There were no 30-day mortalities. Pancreatic fistula developed in four patients (40%), and all resolved without operative intervention. All patients are alive with no recurrence and no new endocrine or exocrine dysfunction. *Conclusion*. CP has similar morbidity and mortality rates to traditional pancreatic resections and may offer a lower incidence of diabetes and exocrine insufficiency.

## Introduction

Traditional pancreatic resections for malignant disease include pancreaticoduodenectomy (PD) and distal pancreatectomy with splenectomy. These operations carry a mortality risk of <5% in experienced hands [1–4]. Morbidity rates for PD range from 30% to 50%, with the most common complication being pancreatic fistula [2,3]. Distal pancreatectomy with splenectomy carries a complication rate of 25–30% [1,4]. These risks are appropriate in a resection for oncologic cure; however, non-traditional pancreatic resections have evolved as a means of minimizing resection of normal parenchyma, including the spleen, for benign disease.

Non-traditional pancreatic resections include pancreatic enucleation, spleen-preserving distal pancreatectomy [5], duodenum-sparing pancreatic head resection [6,7], and central pancreatectomy (CP) [8–19]. CP was first described in the 1950s as a treatment for chronic pancreatitis, and in the treatment of a traumatic pancreatic injury [20]. More recently, CP has been applied to lesions of the pancreatic neck and body with low benign or low-malignant potential histology. This report describes our experience with CP.

## Methods and patients

From May 1999 through January 2004, patients who underwent central pancreatectomy were identified from surgeon records. Hospital charts, radiographic images, and pathologic slides were retrospectively reviewed. Demographic variables, preoperative symptoms, intraoperative factors, and postoperative complications were recorded.

All patients underwent computed tomography (CT) scanning as part of the preoperative evaluation. For those patients in whom CT scan was not adequate in making a diagnosis, other imaging studies were undertaken at the discretion of the surgeon or referring physician.

Our technique for CP is described elsewhere [8]. Briefly, the abdomen was entered via a bilateral subcostal incision. The gastrocolic ligament was divided to enter the lesser sac. The neck of the pancreas was elevated off of the superior mesenteric vein, portal vein, and splenomesenteric confluence. Next, the splenic artery was dissected from the superior border of the pancreas, from the pancreatic head to within 5 cm of the tail.

At this point, it was determined whether a CP could be performed safely, considering the anatomic loca-

Correspondence: Gerard V. Aranha, MD, Loyola University Medical Center, Exs 110-3236, 2160 South First Ave, Maywood, IL 60153, USA. Fax: +1 708 3273565. E-mail: garanha@lumc.edu

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tion of the lesion. Stay sutures were placed 1 cm away from the lesion on the cephalad and caudal aspects of the pancreas. The pancreas was transected proximal and distal to the lesion, with at least 1 cm of normal pancreatic parenchyma on either side. Frozen section analysis was done in all patients and confirmed a benign histology in all cases. In cases of malignant histology, central pancreatectomy was abandoned and standard oncologic resection was performed. The proximal pancreatic remnant was stapled and oversewn, or the pancreas was divided with electrocautery, followed by identification and oversewing of the duct.

A Roux-en-Y pancreaticojejunostomy (PJ) or pancreaticogastrostomy (PG) was constructed to the distal pancreatic remnant. Our technique for PG is also described elsewhere [2]. A closed suction drain was placed near the pancreatico-enteric anastomosis prior to abdominal closure. The drain fluid was routinely tested for amylase after the patient had tolerated two meals of solid food, usually on postoperative day 4 or 5. If the drain amylase was less than three times the serum amylase, the drain was removed. If not, the drain was kept in place until the output was $<10$ ml/day. Patients were maintained on a general diet or allowed nothing by mouth (NPO) with total parenteral nutrition (TPN) according to surgeon preference or the presence of septic complications from the leak. Pancreatic fistula was defined as $>50$ ml/day of amylase-rich fluid from an operatively or postoperative percutaneously placed drain, lasting longer than 2 weeks postoperatively.

## Results

Between May 1999 and January 2004, 10 patients underwent CP. During the same interval, 172 Whipple procedures, 74 distal pancreatectomies and 3 total pancreatectomies were performed. There were no attempted CPs that could not be performed for technical reasons or due to malignant histology on intra-operative frozen section. There were eight female and two male patients, with a median age of 60 years (range 21–75). Patient characteristics are summarized in Table I. Nine of the patients presented with symptoms attributable to their pancreatic lesion: eight patients presented with abdominal pain, two of whom also experienced weight loss; one patient presented with episodes of hypoglycemia. The remaining patient had an incidental finding of a pancreatic body lesion found on a CT scan performed for evaluation of a renal calculus. Preoperative work-up included CT scan in all patients, which was diagnostic for a pancreatic lesion in eight patients. Further imaging was required in two patients. This included endoscopic ultrasound (EUS) in one patient and magnetic resonance imaging with magnetic resonance cholangiopancreatography (MRCP) in another patient. Both of these patients had pancreatitis with no identifiable cause as their presenting symptoms. In both of these patients, the additional imaging studies indicated the presence of a pancreatic mass, which was the indication for surgery. Four patients underwent fine-needle aspiration biopsy of their lesions by the referring services; three of these biopsies revealed a mucinous tumor and the fourth was non-diagnostic.

Median operative time was 255 min (range 160–380 min). Median estimated blood loss was 650 ml (range 200–2000 ml). Tumor location was in the pancreatic neck in four patients, in the body in three patients, and at the junction of the neck and body in three patients. The proximal pancreatic remnant was stapled and oversewn in five patients, while in five patients the pancreas was divided sharply and the duct was identified and oversewn. Six of our patients underwent reconstruction via Roux-en-Y PJ and four of our patients-underwent PG.

Final pathologic analysis revealed serous cystadenoma in three patients, mucinous cystadenoma in three patients, and one patient each with insulinoma, pseudo-papillary tumor, non-functioning neuroendocrine tumor, and focal pancreatitis.

There were no 30-day mortalities and no patient required re-operation. Four patients experienced an uneventful postoperative course. Pancreatic fistula occurred in four patients. Three patients were managed with closed suction drains placed during the initial resection, and one patient required postoperative placement of a percutaneous drain into a peripancreatic fluid collection. Two patients were placed on TPN and allowed nothing by mouth (NPO). The other two patients were allowed to take a regular diet. Median time until fistula closure was 47 days, with a range of 15–120 days.

Two other patients experienced perioperative complications. One patient had an unplanned splenectomy following injury to the splenic capsule, and one patient had hemorrhage from an operatively placed closed suction drain. This was treated by drain repositioning under CT guidance and resolved spontaneously. Median hospital length of stay was 9 days (range 7–25).

With a median follow up of 24 months (range 1–57 months), all patients are alive with no evidence of recurrence. One patient was taking oral hypoglycemics prior to surgery and was discharged on her previous regimen. The remaining patients, all of whom had normal fasting glucose preoperatively, are without evidence of glucose intolerance. No patient has experiened diarrhea or weight loss, or has required treatment for pancreatic exocrine insufficiency.

## Discussion

The two questions that must be answered in choosing a non-traditional pancreatic resection such as CP over the standard pancreaticoduodenectomy and distal pancreatectomy with splenectomy resections

Table I. Summary of patients' clinical and pathologic data.

| Patient | Presentation | Diagnostic studies | Biopsy results | Tumor location | Distal remnant | Pathology | Postoperative complications | Treatment | Follow-up (months) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Pancreatitis | CT; EUS; FNA | Acellular | Body | PG | Nonfunctioning neuroendocrine tumor | No | | 3 |
| 2 | Abdominal pain | CT; ERCP | | Body | PG | Serous adenoma | Fistula-15 days | Percutaneous drain; NPO/TPN | 5 |
| 3 | Incidental finding | CT; FNA | Mucin | Jct neck/body | PG | Mucinous cystadenoma | No | | 10 |
| 4 | Abdominal pain | CT; FNA | Mucin | Neck | PG | Mucous retention cyst | No | | 29 |
| 5 | Abdominal pain, weight loss | CT; EUS | | Jct neck/body | PJ | Serous cystadenoma | Fistula-60 days | NPO/TPN | 60 |
| 6 | Abdominal pain | CT; MRI; MRCP | | Neck | PJ | Pancreatitis with focal hemorrhage | No | | 39 |
| 7 | Abdominal pain, weight loss | CT | | Not specified | PJ | Mucinous cystadenoma, pancreatitis | Hemorrhage from intraoperative drain | Adjustment of drain; resolved spontaneously | 20 |
| 8 | Abdominal pain | CT;FNA | Unknown | Neck | PJ | Solid pseudopapillary tumor | Fistula- 120 days | General diet; OR drain with exchanges | 28 |
| 9 | Abdominal pain | CT; EUS | | Neck | PJ | Serous cystadenoma | Fistula-35 days | General diet; OR placed drain | 36 |
| 10 | Hypoglycemia | CT | | Body | PJ | Insulinoma | Unplanned splenectomy | Vaccination | 25 |

CT, computed tomography; EUS: endoscopically guided ultrasound; FNA, fine-needle aspiration; PG, pancreaticogastrostomy; ERCP, endoscopic retrograde cholangiopancreatography; NPO, nothing by mouth; TPN, total parenteral nutrition; MRI, magnetic resonance imaging; PJ, pancreaticojejunostomy; MRCP, magnetic resonance cholangiopancreatography.

are: (1) is the non-standard resection at least as safe as the traditional operations, both in terms of eradicating the disease process and in morbidity and mortality rates and (2) does performing the non-standard resection offer a benefit in outcome over the traditional resections?

Traditional resections for pancreatic malignancies have undergone improvements in perioperative mortality, with recent published series reporting zero 30-day mortality rates for PD [2] and distal pancreatectomy with splenectomy [21]. Acceptable mortality rates for these operations are $<5\%$ [4], Aggregate mortality across reported series of CP in the English literature remains $<1\%$, a rate comparable to PD and distal pancreatectomy, and appropriate for surgery for benign disease (Table II).

Pancreatic fistula remains one of the most common complications of pancreatic surgery, complicating PD and distal pancreatectomy in 10–25% [21,22] and 5–26% [1,4,23] of patients, respectively. In comparison, the reported rate of pancreatic fistula for CP ranges from 0 to 50% in retrospective reviews containing at least five patients [9,10,13,14,17,19] While our definition of fistula falls within the least strict criteria in a recent review of the definitions of pancreatic fistula [24], such fistulae are more likely to represent clinically significant events. The slightly higher rate of pancreatic fistulae in CP may be a result of the operation requiring management of two pancreatic stumps. In two of our patients, the source of the pancreatic fistula was the pancreaticoenteric anastomosis, as diagnosed by contrast injection of the operatively placed drain, which demonstrated immediate filling of the bowel lumen and visualization of the main pancreatic duct. In the other two patients, the source could not be confirmed radiographically.

Early CP case series [15] report a 15% incidence of pancreaticoenteric anastomotic disruptions requiring reoperation; a more recent series of 53 patients reported 3 cases of reoperation (5.7%) for complications related to the pancreaticoenteric anastomosis with one mortality [16]. There is speculation that the type of anastomosis (PJ vs PG) may influence the incidence of pancreatic fistula in central pancreatectomy. Although prospective data comparing reconstruction with pancreaticojejunostomy vs pancreaticogastrostomy in PD did not reveal a significant difference in fistula formation [25], there are retrospective data supporting a decreased overall risk of complications when using a PG anastomosis [25–28].

This trend was not borne out in the largest series of CP published, which reported PF in 8/26 patients with PJ and 7/25 patients with PG reconstruction [16]. Likewise, the current series did not find a significant difference in pancreatic fistulae between patients who underwent PJ vs PG, although the study is insufficiently powered to detect a difference. It may be difficult to extrapolate data from PD for CP, as patients undergoing CP tend to be younger and have fewer comorbidities. The influence of indication for surgery may play a role in outcome as well, with soft pancreatic parenchyma in patients without pancreatitis predisposing to an increased risk of fistula formation. However, the effect of enteric reconstruction or the quality of the remaining pancreas on complication rate in central pancreatectomy remains to be studied in a prospective fashion.

In the present series, all fistulae healed with nonoperative management. Two patients were managed with TPN and NPO. The other two patients were managed with close observation, and were allowed to eat and go home with their drains in place. This is in concordance with our experience with pancreatic fistulae following distal pancreatectomy, in which patients were found to heal spontaneously without the need for TPN [21].

In addition to pancreatic fistulae, the incidence of postoperative pancreatic exocrine and endocrine insufficiency must be considered when comparing standard resections to CP. The incidence of diabetes following pancreatic resection is thought to relate to the amount of parenchyma removed, as well as the quality of the remaining gland. A 50% resection in healthy adult hemipancreatectomy donors was associated with a 25% incidence of abnormal glucose tolerance and insulin secretion 1 year after resection [29]. In patients undergoing PD for periampullary adenocarcinoma, diabetes was reported in 3% of patients alive at 1 year after resection [22]. Recently, a French series reported a 6% incidence of abnormal

Table II. Comparison of studies of central pancreatectomy in English literature including at least five patients.

| Author | Year | No. of patients | Complications (%) | Pancreatic fistulae (%) | Disease recurrence (%) |
|---|---|---|---|---|---|
| Rotman | 1992 | 14 | 29 | 14 | 0 |
| Ikeda | 1995 | 24 | 12.5 | 12.5 | 0 |
| Iacono | 1998 | 13 | 23 | 23 | 0 |
| Warshaw | 1998 | 12 | 25 | 17 | 0 |
| Partensky | 1998 | 10 | 40 | 40 | 0 |
| Sperti | 2000 | 10 | 40 | 30 | 0 |
| Celis | 2001 | 5 | 0 | 0 | 0 |
| Sauvanet | 2002 | 53 | 40 | 30 | 8 |
| Balzano | 2004 | 32 | 62 | 50 | 0 |
| Present study | 2005 | 10 | 60 | 44 | 0 |

glucose tolerance following CP [16]. In two other studies that performed oral glucose tolerance tests on a total of 13 patients, no patient developed postoperative glucose intolerance [17,18]. The present study found no evidence of postoperative diabetes.

Exocrine insufficiency was noted to occur in 60% of patients studied retrospectively following PD for periampullary adenocarcinoma [22]. In a prospective study by Lemaire and colleagues, fecal fat excretion was found to be elevated in 16 of 17 patients who underwent PD with PG anastomosis for benign pancreatic disease [30]. Eleven of these patients were requiring pancreatic enzyme supplements, which were discontinued prior to testing. Hall *et al.* examined pancreatic exocrine function in 14 patients operated on for periampullary adenocarcinomas with PJ anastomosis and found a significant decrease in exocrine function compared with controls, with 4 of the patients requiring enzyme supplementation to control diarrhea [31].

Reports of postoperative exocrine insufficiency following CP range from 0 to 8% [16,17]. Most studies use clinical criteria such as complaints of diarrhea and weight loss to determine the presence of exocrine dysfunction [10–12,16,19]. Rotman *et al.* [15] studied eight patients a mean of 36 months after CP and found one patient with elevated fecal fat excretion. Sperti *et al.* [17] performed fecal chymotrypsin testing on 10 patients at a mean of 37 months after CP and found no abnormalities.

Thus, it seems that central pancreatectomy offers a benefit in postoperative endocrine and exocrine dysfunction compared with standard resections. This benefit may become more apparent as longer follow-ups on larger patient numbers become available. In addition to sparing pancreatic parenchyma, CP maintains normal anatomic relationships among the bile duct, Wirsung's duct and the duodenum, which may influence postoperative function. Additional, prospective data are needed to determine this benefit with certainty.

All the patients in the present study clearly had benign disease. Preoperative evaluation for patients potentially undergoing CP included CT scan to evaluate the size and characteristics of the lesion. CT findings that indicate benign disease include small size, circumscription, and homogeneous appearance. Preoperative biopsy is not definitive and is not recommended for this or any other potentially curable pancreatic lesion. Intra-operative frozen section is mandatory to confirm benign histology and allow for a CP instead of conversion to an oncologic resection. Postoperative discovery of malignancy in the resected specimen should prompt return to the operating room for definitive surgery in patients able to tolerate reoperation.

Pathology amenable to CP resection includes serous or mucinous cystadenomas, neuroendocrine tumors, and chronic pancreatitis. Sauvanet *et al.* [16] noted an increased risk of complications, including disease recurrence and postoperative diabetes, in patients undergoing CP for intraductal papillary mucinous neoplasm (IPMN). This tumor may not represent an appropriate indication for CP.

## Conclusion

CP represents an appropriate alternative resection for patients with benign lesions of the neck or body of the pancreas. This technique preserves normal pancreatic parenchyma and the spleen, and therefore minimizes exocrine and endocrine insufficiency. Careful patient selection is important, and operative mortality of $<1\%$ is comparable to that of PD or distal pancreatectomy. Reconstruction by PG may offer a reduction in complication rates. Further investigation is needed to determine the influence of PG vs PJ reconstruction and to confirm the long-term benefits of CP over PD and distal pancreatectomy.

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