



BRIEF ARTICLES

Conservative resection for benign tumors of the proximal pancreas

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Received: June 15, 2009

Revised: July 21, 2009

Accepted: July 28, 2009

Published online: August 28, 2009

resection; Cystadenoma; Enucleation; Insulinoma; Pancreatectomy; Pancreatic fistula; Pancreatic neoplasms

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Huang H, Dong X, Gao SL, Wu YL. Conservative resection for benign tumors of the proximal pancreas. *World J Gastroenterol* 2009; 15(32): 4044-4048 Available from: URL: <http://www.wjgnet.com/1007-9327/15/4044.asp> DOI: <http://dx.doi.org/10.3748/wjg.15.4044>

Abstract

AIM: To evaluate the safety and long-term prognosis of conservative resection (CR) for benign or borderline tumor of the proximal pancreas.

METHODS: We retrospectively analyzed 20 patients who underwent CR at the Second Affiliated Hospital of Zhejiang University School of Medicine between April 2000 and October 2008. For pancreaticojejunostomy, a modified invagination method, continuous circular invaginated pancreaticojejunostomy (CCI-PJ) was used. Modified continuous closed lavage (MCCL) was performed for patients with pancreatic fistula.

RESULTS: The indications were: serous cystadenomas in eight patients, insulinomas in six, non-functional islet cell tumors in three and solid pseudopapillary tumors in three. Perioperative mortality was zero and morbidity was 25%. Overall, pancreatic fistula was present in 25% of patients. At a mean follow up of 42.7 mo, all patients were alive with no recurrence and no new-onset diabetes mellitus or exocrine dysfunction.

CONCLUSION: CR is a safe and effective procedure for patients with benign tumors in the proximal pancreas, with careful CCI-PJ and postoperative MCCL.

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Key words: Adenoma; Islet cell; Conservative

INTRODUCTION

Pancreaticoduodenectomy (PD) and distal pancreatectomy (DP) are standard operations for tumors located in the proximal portion of the pancreas. However, these standard techniques are associated with a significant risk of long-term endocrine and exocrine impairment. Recently, there has been increased interest in conservative surgery in an attempt to preserve as much as possible the pancreatic parenchyma and integrated upper digestive system anatomy. For patients with benign or low-grade malignant tumors, conservative resection (CR) such as central pancreatectomy or enucleation has been investigated to maintain the normal upper digestive system anatomy, and to reduce the risk of development of exocrine and endocrine functional insufficiency. Although CR of the proximal pancreas may be more appropriate and less time-consuming, it has not been used widely previously because of its high morbidity, especially pancreatic fistula. The focus of this study was to evaluate the safety and outcomes of CR for benign or borderline tumors of the head, neck and proximal part of the pancreas.

MATERIALS AND METHODS

Twenty patients with benign or borderline tumors

localized in the head, neck and proximal part of the pancreas, who were treated with central pancreatectomy ($n = 11$) and enucleation ($n = 9$), between April 2000 and October 2008, were analyzed retrospectively. Data on preoperative, intraoperative and postoperative care were collected and maintained on a secure database. Preoperative parameters included demographics, clinical presentation, and exocrine and endocrine evaluation. Preoperative imaging modalities such as abdominal spiral contrast CT and ultrasound imaging were used to evaluate the suitability for surgical resection in all cases. Intraoperative details including operative time, total blood loss, transfusion and the method of surgery were recorded. Postoperative events and clinical outcomes such as surgical complications, mortality, pathological data and long-term follow-up were recorded carefully.

Postoperative pancreatic fistula was defined as drainage of > 50 mL per 24 h of fluid, with amylase content > 3 times serum amylase activity for > 10 d after operation^[1,2]. Perioperative mortality was defined as death in the hospital or within 30 d. Delayed gastric emptying (DGE) was defined to be present when nasogastric intubation was maintained for ≥ 10 d, combined with at least one of the following: vomiting after removal of the nasogastric tube, reinsertion of nasogastric tube, or failure to restore oral feeding^[3]. Fasting glucose blood level was used for the diagnosis of new-onset diabetes^[4]. Exocrine insufficiency was defined as steatorrhea and weight loss requiring pancreatic enzymes supplementation.

Indications for CR of the pancreas

CR was indicated for benign or low-grade malignant lesions localized in the proximal pancreas, especially in young patients. Simple enucleation was used when the tumor was near or at the surface of the pancreas. Great care had to be taken to avoid the main pancreatic duct injury and obtain complete excision during surgery, otherwise central pancreatectomy was chosen. Central pancreatectomy was indicated when the tumor was deeply embedded in the pancreatic parenchyma without clear margin, and was not suitable for enucleation. The distal remnant of the pancreas was kept at least 5 cm in length.

Surgical technique for central pancreatectomy

Central pancreatectomy was performed as reported previously^[5-7]. After transecting the pancreas by electrocautery to the left and right of the tumor, the main pancreatic duct was ligated using a 3-0 silk suture, and the proximal pancreatic stump was oversewn with 3-0 polypropylene in a continuous running fashion. Reconstruction of the distal pancreatic remnant was accomplished with a retrocolic Roux-en-Y pancreaticojejunostomy. For pancreaticojejunostomy, a modified invagination method, continuous circular invaginated pancreaticojejunostomy (CCI-PJ), was used. The remnant of the pancreas was dissected for about 1-3 cm from the cut edge, and several small veins running between the pancreas and the splenic vein

had to be divided and ligated. The pancreatic stump was invaginated into the jejunum, and a single-layer continuous circular anastomosis with 3-0 polypropylene was performed between the full thickness of the resected jejunum and the body of the pancreas. The largest silicon stent that could be passed into the main pancreatic duct was used in all these patients. Finally, four 24-F drainage catheters were placed near the pancreatic anastomosis.

Postoperative management

Antibiotics were used prophylactically for 5 d after operation, but octreotide was not used routinely. Parenteral nutrition and early enteral feeding were administered. Enteral feeding usually began gradually on postoperative day 3. The fluid from the drain tube placed near the pancreatic anastomosis was monitored routinely for volume and amylase level. For those patients with pancreatic fistulas, modified continuous closed lavage (MCCL) was performed as reported in our previous study^[8]. A long 6/8-F silicon tube was inserted into each of the 24-F drainage catheters and pulled out from the lateral part of the catheter about 3-5 cm to the external end. The drainage catheter was connected with a drainage pack. A high volume (20-50 L/d) of normal saline was infused through the silicon tube and eventually ran out into the drainage pack through the same rubber catheter. The lavage volume and duration was adjusted according to the appearance and quality of the outflowing liquid.

Statistical analysis

Results are presented as mean \pm SD. Statistical analysis was performed using SPSS version 15.0 statistical software. Student's *t* test was used for comparison of two independent samples. Categorical variables were compared using the χ^2 or Fisher exact test. $P < 0.05$ was considered statistically significant.

RESULTS

The characteristics of CR patients are summarized in Table 1. Eight patients had serous cystadenoma, six had insulinoma, three had solid pseudopapillary tumors, and three had non-functional islet cell tumors. Each tumor was resected with clear margins, as determined by intraoperative frozen section and confirmed by final pathological examination. Mean tumor diameter was 2.9 cm (range 0.8-10.0 cm). Mean operating time was 236.5 min (range 75-405 min). The mean intraoperative blood loss was 350 mL (range 100-1200 mL). Three patients (15%) required intraoperative blood transfusion. The mortality was zero and morbidity was 25%. Overall occurrence of pancreatic fistula was 25% and DGE was 20%. Compared with 12 cases of PD for benign tumors in the proximal pancreas during the same period in our hospital, the characteristics did not differ significantly between the two groups. The mortality was zero and the morbidity was 25% in both groups.

It should be pointed out that, among five cases of

Table 1 Characteristics of the 20 patients who underwent CR

Patient No.	Age (yr)	Sex	Pathological description	Size (cm)	Lesion location	Operation	Complication	Follow up (mo)
1	75	F	Serous cystadenoma	2.0	Neck	Central pancreatectomy	Pancreatic fistula (significant case) Hemorrhage DGE	100
2	66	M	Non-functional islet cell tumor	2.6	Neck	Enucleation	No	89
3	38	F	Insulinoma	1.0	Proximal body	Enucleation	No	76
4	39	M	Insulinoma	0.8	Uncinate process	Enucleation	No	75
5	62	M	Non-functional islet cell tumor	2.5	Proximal body	Central pancreatectomy	Pancreatic fistula (significant case), perianastomotic fluid collection with infection, DGE	62
6	45	F	Serous cystadenoma	2.8	Proximal body	Central pancreatectomy	No	54
7	12	F	Solid pseudopapillary tumor	3.0	Neck	Enucleation	No	46
8	28	F	Solid pseudopapillary tumor	10.0	Head	Enucleation	Pancreatic fistula (the largest daily volume > 1000 mL in the early postoperative period)	46
9	40	F	Insulinoma	2.0	Proximal body	Central pancreatectomy	No	45
10	61	F	Solid pseudopapillary tumor	1.8	Neck	Central pancreatectomy	No	45
11	39	M	Insulinoma	1.7	Proximal body	Enucleation	No	43
12	62	F	Non-functional islet cell tumor	2.0	Neck	Central pancreatectomy	No	34
13	47	F	Serous cystadenoma	3.0	Neck	Central pancreatectomy	No	34
14	29	F	Insulinoma	2.0	Neck	Central pancreatectomy	No	24
15	29	M	Insulinoma	1.5	Head	Enucleation	No	23
16	55	F	Serous cystadenoma	2.0	Neck	Central pancreatectomy	Pancreatic fistula, DGE	21
17	32	M	Serous cystadenoma	4.0	Proximal body	Central pancreatectomy	No	13
18	39	F	Serous cystadenoma	5.0	Neck	Enucleation	Pancreatic fistula, DGE	10
19	66	M	Serous cystadenoma	4.0	Proximal body	Central pancreatectomy	No	7
20	42	M	Serous cystadenoma	5.0	Head	Enucleation	No	6

CR: Conservative resection; DGE: Delayed gastric emptying.

fistula from 20 CR operations, there were two from nine enucleations and three from 11 central pancreatectomies. Fistula after enucleation usually healed within 7-15 d, by multiple drainage without special intervention. However, in one case of enucleation for a 10-cm solid pseudopapillary tumor located at the head of the pancreas, a small rupture in the main pancreatic duct was found during surgery, and it was repaired by primary suturing with 5-0 polypropylene. The volume of drainage came up to > 1 L/d at the early stage after operation. With MCCL, the fistula healed 15 d later. In the three fistulas from 11 central pancreatectomies, two cases presented with clinically significant pancreatic fistulas that required further medical intervention (Table 1).

After a postoperative follow up of 42.7 mo (range 6-100 mo), all patients were alive without tumor recurrence. No patients developed new-onset diabetes mellitus. However, two cases of new-onset diabetes developed in the PD group. None experienced clinical exocrine insufficiency or required pancreatic enzyme supplements, and three patients needed exocrine substitution in the PD group. Exocrine function of the pancreas was better preserved in the CR than PD group ($P < 0.05$).

DISCUSSION

For tumors located in the head, neck and proximal pancreas, standard or extended pancreatectomy, such as PD, DP and extended DP, which involves resection of a notable amount of normal parenchyma, has been indicated for benign lesions. It has been reported that the rates of new-onset diabetes mellitus and exocrine insufficiency after PD were 10%-40% and 22%-60% respectively^[7,9-12]. Previous reports have shown that 72% of patients became insulin dependent after subtotal left pancreatectomy, whereas 85%-95% resection caused diabetes in all patients^[13,14]. Besides pancreatic parenchyma, the integrated upper digestive and biliary anatomy also plays a key role in maintaining consequent digestive, immunological and coagulative function and neurohormonal regulation of insulin activity^[15]. In addition, Reid-Lombardo *et al*^[16] have reported that the 5- and 10-year cumulative probability of biliary stricture after PD for benign lesions was 8% and 13%; that is why, in recent years, CR, such as central pancreatectomy and enucleation, has been investigated with great interest. In the present study, with a mean of 42.7 mo follow-up, there was no new-onset diabetes mellitus

Table 2 Postoperative morbidity and mortality rates of CR for benign tumors in the proximal pancreas: summary of cases in the literature

Author	Year	No. of cases	Morbidity rate (%)	Pancreatic fistula (%)	Mortality rate (%)
Sperti <i>et al</i> ^[21]	2000	10 ¹	40	30	0
Balzano <i>et al</i> ^[6]	2003	46 ²	51	39	0
Efron <i>et al</i> ^[24]	2004	14 ¹	50	36	0
Roggin <i>et al</i> ^[23]	2006	10 ¹	60	30	0
Brown <i>et al</i> ^[25]	2006	10 ¹	60	40	0
Christein <i>et al</i> ^[22]	2006	8 ¹	63	63	0
Falconi <i>et al</i> ^[7]	2007	36 ³	44	31	0
Present series	2007	20	25	25	0

¹Central pancreatectomy; ²Thirty two central pancreatectomies and 14 enucleations; ³Twenty one central pancreatectomies and 15 enucleations.

and pancreatic exocrine insufficiency, which is the same as previously reported^[17-23]. Moreover, in our study, the mean age of patients was only 45.3 years old. For these young patients with benign pancreatic disease, CR might be much more significant in achieving good quality of life, because CR can avoid long-term anastomotic complications and pancreatic insufficiency.

However, conservative pancreatectomy has not been used widely to date because of its high morbidity rate, especially pancreatic fistula. It has been reported that the morbidity rate of CR ranged from 35% to 63% (Table 2), which is much higher than that for PD and DP^[6,7,22-25]. In our study, the morbidity rate of CR was 25%. Overall pancreatic fistula rate was 25%, and DGE rate was 20%.

The pancreatic fistula rate in our study was a little better than that reported since 2000 (Table 2), which has ranged from 30% to 63%^[6,7,22-25]. In our study, although fistula developed in five of 20 patients, only two with clinically significant fistula required further intervention. According to our experience here, CCI-PJ and efficient MCCL might be responsible for lower morbidity in CR. With CCI-PJ, the stump of the pancreas and the cut edge of the jejunum could be connected closely with polypropylene sutures, which were used for anastomosis of the blood vessels. After postoperative pancreatic fistula has been diagnosed clinically, postoperative MCCL with a high volume of normal saline (20-50 L/d) was necessary to control the pancreatic fistula effectively. The advantage of MCCL compared with general lavage is that there was no concern about the imbalance between ingoing and outgoing fluids because the small silicon tube for irrigation was placed at the tip of the large catheters for outgoing fluid. With MCCL, most patients with pancreatic fistula recover without further surgical intervention.

In conclusion, CR for benign or borderline tumors of the proximal pancreas could be performed safely with careful CCI-PJ and postoperative MCCL. It is useful for preserving long-term pancreatic function.

COMMENTS

Background

In recent years, there has been a marked increase of incidentally discovered benign or borderline tumor of the pancreas using advanced diagnostic imaging techniques. The resection of benign lesions located in the proximal portion of

the pancreas traditionally has been accomplished by pancreaticoduodenectomy and distal pancreatectomy. These extended resections result in removal of normal pancreatic tissue, which increased the risk of loss of exocrine and endocrine function.

Research frontiers

Conservative pancreatic resection including pancreatic enucleation and central pancreatectomy has evolved as a means of preserving as much as possible the pancreatic parenchyma and integrated upper digestive system anatomy. In the present study, the authors evaluated the safety and long-term prognosis of patients who underwent conservative resection (CR) for benign or borderline tumors of the proximal pancreas.

Innovations and breakthroughs

CR for benign or borderline tumors of the proximal pancreas could be performed safely with careful continuous circular invaginated pancreaticojejunostomy and postoperative modified continuous closed lavage (MCCL). It is effective for preserving long-term pancreatic function.

Applications

CR is a safe and reasonable technique for benign tumors or lesions of low malignant potential in the proximal pancreas. To obtain good results, careful patient selection and experience in pancreatic surgery are of paramount importance in this setting.

Terminology

Central pancreatectomy, also known as middle pancreatectomy, is a segmental resection of the pancreas. Dagradi and Serio performed the first central pancreatectomy with an oncological indication in 1984. The main advantage of this operation is that it permits preservation of most of the pancreatic parenchyma, extrahepatic bile duct, duodenum, and spleen.

Peer review

The article is well written and demonstrates the results of CR of benign tumor of the proximal pancreas. CR is a procedure that offers benefits for benign and low-grade malignant pancreatic tumors, because it allows preservation of endocrine and exocrine functions. A lower risk of typical postoperative complications following pancreatectomy is especially important in young patients, which is stressed by authors of this study. A presented method (MCCL) of management in patients with pancreatic fistula may be useful for other researchers.

REFERENCES

- 1 B  chler MW, Friess H, Wagner M, Kulli C, Wagoner V, Z'Graggen K. Pancreatic fistula after pancreatic head resection. *Br J Surg* 2000; **87**: 883-889
- 2 Yeo CJ, Cameron JL, Maher MM, Sauter PK, Zahurak ML, Talamini MA, Lillemoe KD, Pitt HA. A prospective randomized trial of pancreaticogastrostomy versus pancreaticojejunostomy after pancreaticoduodenectomy. *Ann Surg* 1995; **222**: 580-588; discussion 588-592
- 3 Yeo CJ, Barry MK, Sauter PK, Sostre S, Lillemoe KD, Pitt HA, Cameron JL. Erythromycin accelerates gastric emptying after pancreaticoduodenectomy. A prospective, randomized, placebo-controlled trial. *Ann Surg* 1993; **218**: 229-237; discussion 237-238
- 4 Alberti KG, Zimmet PZ. Definition, diagnosis and

- classification of diabetes mellitus and its complications. Part 1: diagnosis and classification of diabetes mellitus provisional report of a WHO consultation. *Diabet Med* 1998; **15**: 539-553
- 5 **Crippa S**, Bassi C, Salvia R, Falconi M, Butturini G, Pederzoli P. Enucleation of pancreatic neoplasms. *Br J Surg* 2007; **94**: 1254-1259
 - 6 **Balzano G**, Zerbi A, Veronesi P, Cristallo M, Di Carlo V. Surgical treatment of benign and borderline neoplasms of the pancreatic body. *Dig Surg* 2003; **20**: 506-510
 - 7 **Falconi M**, Mantovani W, Crippa S, Mascetta G, Salvia R, Pederzoli P. Pancreatic insufficiency after different resections for benign tumours. *Br J Surg* 2008; **95**: 85-91
 - 8 **Dong X**, Gao SL, Xie QP, Xu L, Xu YL, Wu YL. In situ high-volume modified continuous closed and/or open lavage for infected necrotizing pancreatitis. *Pancreas* 2008; **36**: 44-49
 - 9 **Andersen HB**, Baden H, Brahe NE, Burcharth F. Pancreaticoduodenectomy for periampullary adenocarcinoma. *J Am Coll Surg* 1994; **179**: 545-552
 - 10 **Lemaire E**, O'Toole D, Sauvanet A, Hammel P, Belghiti J, Ruszniewski P. Functional and morphological changes in the pancreatic remnant following pancreaticoduodenectomy with pancreaticogastric anastomosis. *Br J Surg* 2000; **87**: 434-438
 - 11 **Huang JJ**, Yeo CJ, Sohn TA, Lillemoe KD, Sauter PK, Coleman J, Hruban RH, Cameron JL. Quality of life and outcomes after pancreaticoduodenectomy. *Ann Surg* 2000; **231**: 890-898
 - 12 **McLeod RS**, Taylor BR, O'Connor BI, Greenberg GR, Jeejeebhoy KN, Royall D, Langer B. Quality of life, nutritional status, and gastrointestinal hormone profile following the Whipple procedure. *Am J Surg* 1995; **169**: 179-185
 - 13 **Frey CF**, Child CG, Fry W. Pancreatectomy for chronic pancreatitis. *Ann Surg* 1976; **184**: 403-413
 - 14 **Morrow CE**, Cohen JL, Sutherland DE, Najarian JS. Chronic pancreatitis: long-term surgical results of pancreatic duct drainage, pancreatic resection, and near-total pancreatectomy and islet autotransplantation. *Surgery* 1984; **96**: 608-616
 - 15 **Yasuda H**, Takada T, Toyota N, Amano H, Yoshida M, Takada Y, Takada K, Hijikata H. Limited pancreatectomy: significance of postoperative maintenance of pancreatic exocrine function. *J Hepatobiliary Pancreat Surg* 2000; **7**: 466-472
 - 16 **Reid-Lombardo KM**, Ramos-De la Medina A, Thomsen K, Harmsen WS, Farnell MB. Long-term anastomotic complications after pancreaticoduodenectomy for benign diseases. *J Gastrointest Surg* 2007; **11**: 1704-1711
 - 17 **Warshaw AL**, Rattner DW, Fernández-del Castillo C, Z'graggen K. Middle segment pancreatectomy: a novel technique for conserving pancreatic tissue. *Arch Surg* 1998; **133**: 327-331
 - 18 **Iacono C**, Bortolasi L, Serio G. Is there a place for central pancreatectomy in pancreatic surgery? *J Gastrointest Surg* 1998; **2**: 509-516; discussion 516-517
 - 19 **Rotman N**, Sastre B, Fagniez PL. Medial pancreatectomy for tumors of the neck of the pancreas. *Surgery* 1993; **113**: 532-535
 - 20 **Sauvanet A**, Partensky C, Sastre B, Gigot JF, Fagniez PL, Tuech JJ, Millat B, Berdah S, Dousset B, Jaeck D, Le Treut YP, Letoublon C. Medial pancreatectomy: a multi-institutional retrospective study of 53 patients by the French Pancreas Club. *Surgery* 2002; **132**: 836-843
 - 21 **Sperti C**, Pasquali C, Ferronato A, Pedrazzoli S. Median pancreatectomy for tumors of the neck and body of the pancreas. *J Am Coll Surg* 2000; **190**: 711-716
 - 22 **Christein JD**, Smoot RL, Farnell MB. Central pancreatectomy: a technique for the resection of pancreatic neck lesions. *Arch Surg* 2006; **141**: 293-299
 - 23 **Roggin KK**, Rudloff U, Blumgart LH, Brennan MF. Central pancreatectomy revisited. *J Gastrointest Surg* 2006; **10**: 804-812
 - 24 **Efron DT**, Lillemoe KD, Cameron JL, Yeo CJ. Central pancreatectomy with pancreaticogastrostomy for benign pancreatic pathology. *J Gastrointest Surg* 2004; **8**: 532-538
 - 25 **Brown KM**, Shoup M, Abodeely A, Hodul P, Brems JJ, Aranha GV. Central pancreatectomy for benign pancreatic lesions. *HPB (Oxford)* 2006; **8**: 142-147

S- Editor Tian L L- Editor Kerr C E- Editor Yin DH