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BRIEF ARTICLE

Middle segmental pancreatectomy: A safe and organ-preserving option for benign and low-grade malignant lesions

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Abstract

AIM: To study the feasibility and safety of middle segmental pancreatectomy (MSP) compared with pancreaticoduodenectomy (PD) and extended distal pancreatectomy (EDP).

METHODS: We studied retrospectively 36 cases that underwent MSP, 44 patients who underwent PD, and 26 who underwent EDP with benign or low-grade malignant lesions in the mid-portion of the pancreas, between April 2003 and December 2009 in Ruijin Hospital. The perioperative outcomes and long-term outcomes of MSP were compared with those of EDP and PD. Perioperative outcomes included operative time, intraoperative hemorrhage, transfusion, pancreatic fistula, intra-abdominal abscess/infection, postoperative bleeding, reoperation, mortality, and postoperative hospital time. Long-term outcomes, including tumor recurrence, new-onset diabetes mellitus (DM), and pancreatic exocrine insufficiency, were evaluated.

RESULTS: Intraoperative hemorrhage was 316.1 ± 309.6, 852.2 ± 877.8 and 526.9 ± 414.5 mL for the MSP, PD and EDP groups, respectively ($P < 0.05$). The mean postoperative daily fasting blood glucose level was significantly lower in the MSP group than in the EDP group (6.3 ± 1.5 mmol/L *vs* 7.3 ± 1.5 mmol/L, $P < 0.05$). The rate of pancreatic fistula was higher in the MSP group than in the PD group (42% *vs* 20.5%, $P = 0.039$), all of the fistulas after MSP corresponded to grade A (9/15) or B (6/15) and were sealed following conservative treatment. There was no significant difference in the mean postoperative hospital stay between the MSP group and the other two groups. After a mean follow-up of 44 mo, no tumor recurrences were found, only one patient (2.8%) in the MSP group *vs* five (21.7%) in the EDP group developed new-onset insulin-dependent DM postoperatively ($P = 0.029$). Moreover, significantly fewer patients in the MSP group than in the PD (0% *vs* 33.3%, $P < 0.001$) and EDP (0% *vs* 21.7%, $P = 0.007$) required enzyme substitution.

CONCLUSION: MSP is a safe and organ-preserving option for benign or low-grade malignant lesions in the neck and proximal body of the pancreas.

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Key words: Middle segmental pancreatectomy; Pancreaticoduodenectomy; Extended distal pancreatectomy; Pancreatic fistula; Pancreatic endocrine function; Pancreatic exocrine function

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INTRODUCTION

Clinically, surgical treatment for benign or low-grade malignant lesions of the pancreatic neck and body is often performed using "traditional" procedures such as pancreaticoduodenectomy (PD) or extended distal pancreatectomy (EDP). However, these approaches result in a significant and unnecessary loss of normal pancreatic parenchyma, with subsequent impairment of exocrine and endocrine functions, and the loss of the upper gastrointestinal and biliary anatomy in PD, and the spleen in EDP. In addition, tumor enucleation is only suitable for small and superficial lesions that do not involve the main pancreatic duct. Furthermore, enucleation is associated with high risk for major complications, including pancreatic leakage, and tumor recurrence cannot be ignored because of incomplete removal. Therefore, preventing unnecessary loss of pancreatic tissue and avoiding further deteriorations in the endocrine and exocrine pancreatic functions are huge challenges for surgeons managing benign and low-grade malignant lesions in the neck or the proximal body of the pancreas that cannot be managed by enucleation. Furthermore, it would be beneficial for the patient if PD or DP could be avoided.

Since it was first reported by Guillemin *et al*[1], middle segmental pancreatectomy (MSP) has increasingly been applied for some lesions, including chronic pancreatitis, traumatic injury, and benign and borderline lesions localized at the neck and body of pancreas[2-10]. Several recent reports have compared the morbidity, quality of life, and other outcomes in patients with chronic pancreatitis, benign, and low-grade malignant pancreatic tumors after MSP or traditional surgical procedures[5,11-18]. The purpose of our study was to compare the perioperative safety and the long-term effects, including the preservation of pancreatic endocrine and exocrine function, following MSP, PD or EDP in patients with benign, borderline or low-grade malignant lesions.

MATERIALS AND METHODS

Ethics

The Ethics Committee of Ruijin Hospital Shanghai Jiaotong University School of Medicine approved the study. All patients provided informed written consent.

Patient tissue

One hundred and six patients with benign or low-grade malignant tumors (without chronic pancreatitis) in the neck or proximal body of pancreas underwent MSP (n = 36), PD (n = 44) or EDP (n = 26) between April 2003 and December 2009 in Department of General Surgery, Ruijin Hospital (affiliated to Shanghai Jiao Tong University School of Medicine). The same surgeons performed all the surgical procedures. All patients received computed tomography (CT) scans and abdominal ultrasonography before surgery to determine the location of the lesion and its relationship with mesenteric vessels. The indication for MSP was a lesion localized in the neck or proximal body of the pancreas without evidence of high-grade malignancy. Intraoperative frozen tissue sections were analyzed in all patients to exclude pancreatic adenocarcinoma and to ensure that the resection margins were clear, which was subsequently confirmed by histopathological examination.

Patient characteristics retrieved from medical records included their age, sex, presence of diabetes mellitus (DM) and mean preoperative blood glucose levels. DM was diagnosed based on abnormal fasting blood glucose levels or positive results following an oral glucose tolerance test. Tumor variables included tumor size, pathology and specific position. The location of the tumor was divided into four categories: head-neck, neck, neck-body, and body of the pancreas (Figure 1).

We compared the perioperative survival state and long-term changes in exocrine and endocrine function between MSP patients and patients with PD or EDP using matched-pairs analyses. Patients were matched for age, sex, preoperative DM, as well as tumor histopathology, size, and position (Table 1).

Surgical procedures for MSP

After making a bilateral subcostal incision with an upper midline extension to the xiphoid, the gastrocolic ligament was divided to open the lesser sac and expose the pancreas. The posterior peritoneum along the inferior and superior margins of the gland was dissected and the superior mesenteric vein was identified under the neck of the pancreas. The splenic vein was carefully divided away from the pancreas and all of the small branches of the pancreas draining into the splenic vein were ligated. The involved pancreatic segment was mobilized on both cephalic and caudal sides. The pancreas was then sectioned with an electroscalpel with a gap of at least 1-cm away from the tumor, while the limits for the cephalic and caudal sides were the gastroduodenal artery and a $\geqslant$ 5 cm gap from the distal pancreas, respectively. The two resection margins were frozen and prepared for imaging to confirm tumor-free resection. Hemostasis of the cephalic and caudal stumps of pancreas was performed with interrupted 4-0 non-absorbable stitches, and the cephalic pancreatic cut surface was closed by Endo-GIA™ 60-2.5 auto sutures (Johnson Medical Ltd., China) or continuous suture using 4-0 prolene (Figure 2). A small catheter was inserted to maintain the patency of the pancreatic duct on the distal side. The distal side stump was reconstructed by Roux-en-Y pancreaticojejunostomy (PJ, n = 22) or pancreaticogastrostomy (PG, n = 14) (Figure 3). Two

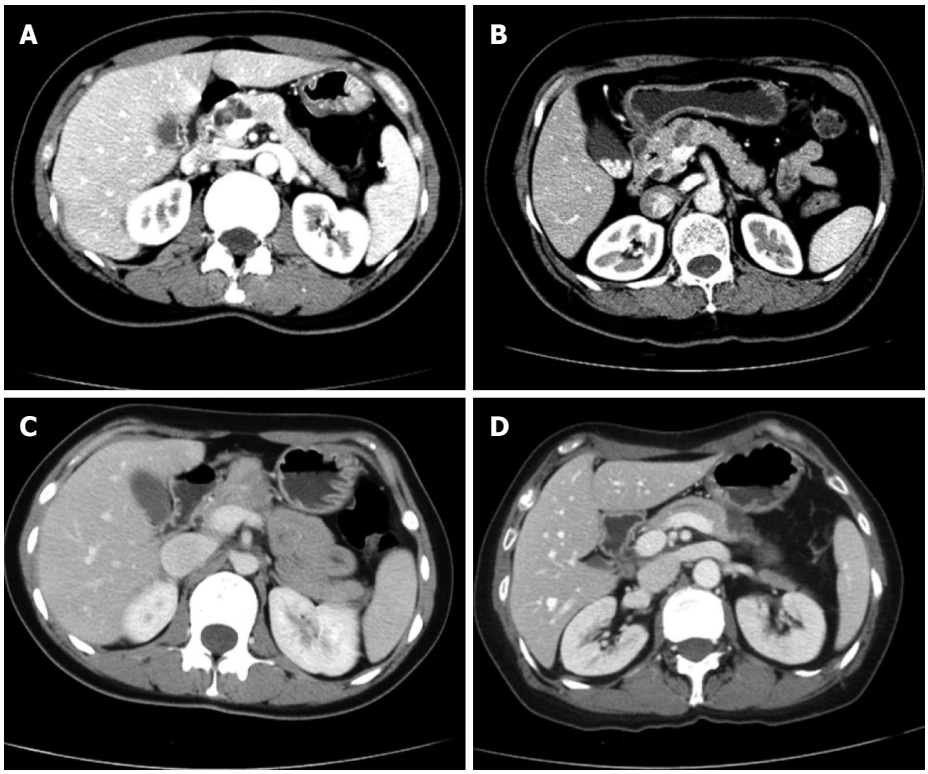

Figure 1 Location of lesions in the pancreas. A: Head-neck; B: Neck; C: Neck-body; D: Body.

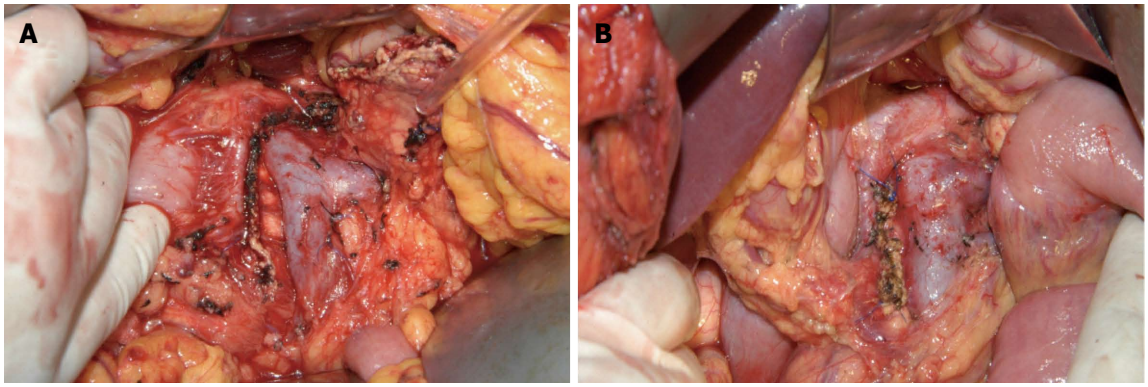

Figure 2 The surgical approach of the cephalic pancreatic cut surface. A: Closed by Endo-GIA™ 60-2.5 auto suture; B: Continuous suture using 4-0 prolene;

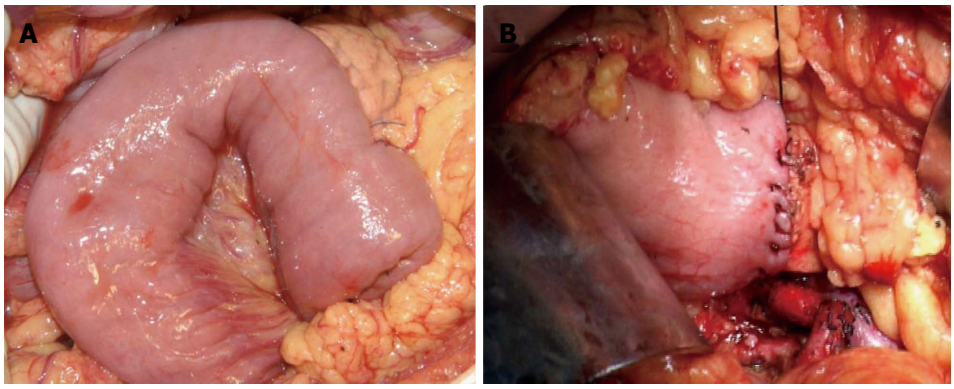

Figure 3 The reconstruction of the distal side stump. A: Pancreaticojejunostomy; B: Pancreaticogastrostomy.

drainage tubes were placed close to the closed cephalic stump and the region of the pancreatic anastomosis. The drains were not removed until the drainage fluid volume was < 10 mL/d and the amylase value was < 300 U/L.

Perioperative outcomes

Perioperative outcomes included operative time, intraoperative hemorrhage, transfusion, pancreatic fistula, intra-abdominal abscess/infection, postoperative bleeding,

Table 1 Matched-pairs analysis of patient characteristics between patients who underwent middle segmental pancreatectomy, pancreaticoduodenectomy or extended distal pancreatectomy

Variable	PD (n = 44)	MSP (n = 36)	EDP (n = 26)	P value	
				PD *vs* MSP	MSP *vs* EDP
Patient characteristics					
Gender (M/F)	16/28	9/27	11/15	NS	NS
Age (yr)	50 ± 14 (range 18-71)	49 ± 15 (range 23-76)	49 ± 12 (range 22-79)	NS	NS
Tumor type					
Cyst adenomas	13	16	16	NS	NS
Endocrine	1	3	2		
IPMN	7	3	2		
SPT	16	10	1		
Others	7	4	5		
Tumor size (mm)	30.8 ± 9.6	26.5 ± 14	31.3 ± 13.5	NS	NS
Tumor location					
Head-neck	23	8	0	NS	NS
Neck	16	10	0		
Neck-body	5	9	15		
Body	0	9	11		
Preoperative DM	5	2	4	NS	NS

MSP: Middle segmental pancreatectomy; PD: Pancreaticoduodenectomy; EPD: Extended distal pancreatectomy; IPMN: Intraductal papillary mucinous neoplasms; SPT: Solid pseudopapillary tumor; DM: Diabetes mellitus; NS: Not significant.

reoperation, mortality, and postoperative hospital time. Pancreatic fistulae were graded based on the International Study Group for Pancreatic Fistula (ISGPF) criteria[19]. Pre- and postoperative nutritional status (total protein, albumin, and hemoglobin) was evaluated using the formula: (discharge numerical value - preoperative numerical value)/preoperative numerical value × 100 (%). Nutritional parameters were measured on the day of admission and the seventh postoperative day.

For postoperative glycemic control, the following approach was used in all patients. First, insulin was added to the glucose solution (1 U insulin/4-6 g glucose). Second, blood glucose was monitored every 6 h and additional insulin was given if blood glucose exceeded 10 mmol/L. Third, long-acting insulin was given when blood sugar was not well controlled using the above method. Glycemic control was determined as the mean daily fasting blood glucose.

Long-term outcomes

All patients were evaluated after a median follow-up of 44 mo (range 4-72 mo). Our aim was to evaluate the long-term changes in endocrine and exocrine functions, body weight change, and tumor recurrence, based on radiological, clinical and laboratory assessments. New-onset DM was diagnosed according to the criteria of the World Health Organization[20]. Pancreatic exocrine insufficiency was defined as diarrhea and steatorrhea, and was treated by daily enzyme administration.

Statistical analysis

SPSS software (SPSS Inc., Chicago, IL, United States) was used for all statistical analysis. Continuous variables were summarized as mean ± SD and categorical variables as frequency and percentage. Two-sample t tests and Pearson's χ^2 test or Fisher's exact test were used to compare continuous and categorical variables, respectively. The Wilcoxon rank sum test was used to compare body weight change. P values < 0.05 were considered statistically significant.

RESULTS

Perioperative outcomes

The perioperative outcomes are shown in Table 2. No in-hospital death occurred after the operation in any group. A statistically significant difference in operation time was found between the PD and MSP groups (333.5 ± 97 min *vs* 222.1 ± 62.1 min, respectively; $P < 0.001$). Intraoperative hemorrhage was 316.1 ± 309.6, 852.2 ± 877.8 and 526.9 ± 414.5 mL for the MSP, PD and EDP groups, respectively ($P < 0.05$). The splenic artery and vein, as well as the spleen, were preserved in all patients treated with MSP and PD; however, these were removed in all patients who underwent EDP. There were no differences in postoperative hospital time between the MSP group and the PD and EDP groups. The duration of gastrointestinal recovery was shorter in the MSP group than in the PD group ($P < 0.05$). The rate of pancreatic fistula was higher in the MSP group than in the other groups, reaching statistical significance between the MSP and PD groups ($P < 0.05$). However, the pancreatic fistulas in the MSP group corresponded to ISGPF Grade A (n = 9/15) or B (n = 6/15), and there was no significant difference in the pancreatic fistulas rate between PJ (9/22) and PG (6/14) reconstruction methods in MSP group ($P > 0.05$). All of the fistulas after MSP were sealed following conservative treatment. Two patients in the PD group underwent reoperation, one because of postoperative bleeding and the other as a result of intra-abdominal infection.

There were no differences in preoperative mean blood glucose levels between the MSP group and the PD and

Table 2 Perioperative outcomes for middle segmental pancreatectomy, pancreaticoduodenectomy and extended distal pancreatectomy *n* (%)

Variable	PD (*n* = 44)	MSP (*n* = 36)	EDP (*n* = 26)	*P* value	
				PD *vs* MSP	MSP *vs* EDP
Operation time (min)	333.5 ± 97	222.1 ± 62.1	202.0 ± 60.7	< 0.001	> 0.05
IPH (mL)	852.2 ± 877.8	316.1 ± 309.6	526.9 ± 414.5	< 0.001	0.025
PT (d)	31 ± 29	29 ± 23	22 ± 10	NS	> 0.05
Reoperation	2 (4.5)	0 (0.0)	0 (0.0)	NS	
DGR (d)	5.5 ± 2.1	4.4 ± 2.0	3.2 ± 1.5	0.031	0.008
Bleeding	2 (4.5)	1 (2.8)	1 (3.8)	NS	NS
Intra-abdominal infection	4 (9.1)	1 (2.8)	1 (3.8)	NS	NS
Pancreatic fistula	9 (20.5)	15 (42)	8 (31)	0.039	NS
Nutritional status					
Change in TP (%)	-0.5 ± 14.3	3.1 ± 12.4	-6.6 ± 9.5	NS	0.002
Change in Alb (%)	-3.6 ± 15.6	0.8 ± 14.3	-8.2 ± 14.7	NS	0.019
Change in Hb (%)	-13.3 ± 12.6	-11.9 ± 13.2	-14.3 ± 8.0	NS	NS
Mean blood glucose (mmol/L)					
Preoperative	5.0 ± 1.1	4.9 ± 0.6	5.2 ± 1.6	NS	NS
Postoperative	6.7 ± 1.8	6.3 ± 1.5	7.3 ± 1.5	NS	0.013

IPH: Intraoperative hemorrhage; PT: Postoperative time; DGR: Duration of gastrointestinal recovery; TP: Total protein; Alb: Albumin; Hb: Hemoglobin; MSP: Middle segmental pancreatectomy; PD: Pancreaticoduodenectomy; EPD: Extended distal pancreatectomy; NS: Not significant.

EDP groups. However, the mean postoperative daily fasting blood glucose level was significantly lower in the MSP group than in the EDP group ($P < 0.05$). Serum protein is an important clinical and biochemical marker of the patients' nutritional status. Serum total protein and albumin levels were significantly higher in the MSP group than in the EDP group ($P < 0.01$ and $P < 0.05$, respectively).

Long-term outcomes

The long-term outcomes of patients were assessed by telephone interview until March 2010. The median follow-up time was 44 mo (range 4-72 mo). Two and three patients were lost to follow-up in the PD and EDP groups, respectively. The long-term outcomes are shown in Table 3. No tumor recurrence occurred in any of the patients. There was no significant difference in bodyweight change between groups MSP and PD ($P = 0.701$), or MSP and EDP ($P = 0.568$). Only one patient (2.8%) in the MSP group *vs* five (21.7%) in the EDP group developed new-onset insulin-dependent DM postoperatively, which was statistically significant ($P < 0.05$). Moreover, significantly fewer patients (0%) in the MSP group than in the PD (33.3%, $P < 0.001$) and EDP (21.7%, $P < 0.01$) required enzyme substitution, indicating superior preservation of the pancreatic exocrine function with MSP than with other approaches.

DISCUSSION

In recent years, benign and borderline pancreatic lesions have been diagnosed more frequently because of the increased use of high-resolution cross-sectional imaging modalities, such as CT and magnetic resonance imaging[21,22]. As many of these lesions are noninvasive at the time of discovery, parenchymal-sparing techniques may be beneficial to preserve endocrine and exocrine pancreatic function[23-25]. Enucleation is generally appropriate for small lesions that do not involve the main pancreatic duct[26,27]. However, it is associated with a high incidence of pancreatic fistula and pseudocyst formation[28]. Therefore, traditional resection methods (*e.g.*, PD and EDP) are still used to treat lesions in the pancreatic neck or proximal body. These resection methods sacrifice a considerable portion of the normal pancreatic tissue, leading to marked postoperative deteriorations in exocrine and endocrine pancreatic functions[29-31]. Moreover, the loss of the duodenum alters the natural passage of food, leading to an abnormal digestive process. Similarly, bilio-digestive anastomosis increases the risk of ascending cholangitis and subsequently intrahepatic abscesses in PD[32]. Surgeons performing EDP often remove a large amount of normal pancreatic tissue and sometimes the spleen. Splenectomy carries some risks, including portal vein thrombosis, postsplenectomy sepsis, and reduced immune function[3-5,33,34]. MSP avoids extensive loss of normal pancreatic tissue as compared with PD and EDP. Theoretically, MSP also preserves digestive tract continuity, as well as the spleen, potentially reducing postoperative morbidity as compared with PD or EDP. However, MSP appears to be associated with a higher incidence of pancreatic fistula compared with both PD and EDP[11-14,16,35]. This is possibly caused by the need to manage two pancreatic remnants by anastomosis or closure. In this study, the perioperative survival and long-term outcomes were examined in patients with lesions in the neck and proximal body of the pancreas treated by PD, EDP or MSP.

In this study, we found that total blood loss during surgery was less in the MSP group than in the PD and EPD groups. The greater blood loss in the PD group may be caused by the large volume of tissue removed and the complexity of the surgical procedure. Similarly, EDP may be complicated in patients where the surgeon experiences

Table 3 Long-term outcomes following middle segmental pancreatectomy, pancreaticoduodenectomy and extended distal pancreatectomy *n* (%)

Variable	PD (*n* = 42)	MSP (*n* = 36)	EDP (*n* = 23)	*P* value	
				PD *vs* MSP	MSP *vs* EDP
Exocrine and endocrine function					
New-onset DM	6 (14.3)	1 (2.8)	5 (21.7)	NS	0.029
NIDDM	4	1	3		
IDDM	2	0	2		
Enzyme substitution	14 (33.3)	0	5 (21.7)	< 0.001	0.007
Anorexia	9 (21.4)	3 (8.3)	1 (4.3)	NS	NS
Nausea and vomiting	5 (11.9)	2 (5.6)	0	NS	NS
Abdominal distention and diarrhea	16 (38.1)	3 (8.3)	2 (8.7)	0.005	NS
Tumor recurrence	0	0	0		
Body weight change[1]					
Weight gain	16	15	8		
No change	14	12	8	NS	NS
Weight reduction	12	9	7		

[1]Wilcoxon rank sum test. DM: Diabetes mellitus; NIDDM: Non insulin dependent diabetes mellitus; IDDM: Insulin dependent diabetes mellitus; MSP: Middle segmental pancreatectomy; PD: Pancreaticoduodenectomy; EPD: Extended distal pancreatectomy; NS: Not significant.

difficulties in exposing and isolating the spleen, which may result in injury to the spleen parenchyma or splenic vein and artery, leading to significant blood loss. Blind suturing and electric coagulation can also lead to potentially serious consequences. In such cases, the spleen must also be removed. Notably, we found that MSP was easier to perform compared with PD and EDP, because of the smaller volume of tissue to be removed, excellent exposure, and ease of handling the splenic artery and vein branches. Reconstruction *via* Roux-en-Y PJ or PG should not increase the risk of bleeding when performed by experienced surgeons. A further advantage of MSP was its shorter operation time compared with PD. Interestingly, operation time was not different between MSP and EDP, even though PJ or PG was necessary with MSP.

Compared with PD and EDP, MSP was not associated with increased mortality, but was associated with greater postoperative morbidity, notably a higher frequency of pancreatic fistula noted in previous studies[5,11-18]. Similar to these reports, the fistula rate after MSP in our study was 42% (15/36), higher than that after PD (20.5%), but was not significantly different to that after EDP (31%). There was no significant difference in pancreatic fistulas rate between PJ (9/22) and PG (6/14) reconstruction methods in MSP group. However, all of the pancreatic fistulae in our series corresponded to ISGPF grade A or B, and were sealed by conservative measures. This may explain why the postoperative hospital time was not extended following MSP as compared with PD or EDP. Based on these data, we believe that MSP is a safe operation with morbidity and mortality rates comparable with those of PD or EDP.

PD and EDP result in marked deteriorations in pancreatic exocrine and endocrine functions. For example, Shikano *et al*[17] reported that the incidence of DM ranged from 10% to 24% after PD and from 8% to 60% after EDP in patients with normal pancreatic parenchyma. However, in patients with chronic pancreatitis, the incidence of DM increases to 40% and 85% after PD and DP, respectively. Meanwhile, the incidence of impaired pancreatic exocrine function ranged from 30% to 60%, even in the absence of chronic pancreatitis. However, the major advantage of MSP is the potential to retain more pancreatic exocrine and endocrine function than with PD and EDP. In their literature review, Allendorf *et al*[36] reported no cases of impaired exocrine function and only two cases of abnormal endocrine function among 26 patients who underwent MSP. In another literature review, the rate of exocrine insufficiency was 5% and the rate of endocrine insufficiency was 4% among 100 patients who underwent MSP[10]. In the current series, one of 36 patients developed new-onset DM following MSP, *vs* 21.7% of patients (5/23) after EDP and 14.3% of patients (6/42) after PD. Moreover, none of the patients in the MSP group required pancreatic enzyme substitution, *vs* 33.3% (14/42) and 21.7% (5/23) of patients after PD and EDP, respectively. Matched-pairs analysis comparing MSP with PD or EDP confirmed the superiority of this organ-preserving procedure. Furthermore, long-term exocrine and endocrine pancreatic function was significantly better preserved after MSP than after PD or EDP.

It is important to consider that MSP provides inadequate tissue resection for cancers because of incomplete dissection of soft tissue and nodes. Furthermore, it does not remove the putative lymphatic and venous drainage bed along the distal pancreas and at the splenic hilum from which many malignant pancreatic tumors are thought to spread. Therefore, MSP is contraindicated for invasive pancreatic tumors and is currently limited to benign and low-malignant potential conditions, such as intraductal papillary mucinous neoplasms, mucinous cystic neoplasms, serous cystadenomas, solid pseudopapillary neoplasms, endocrine tumors and other less frequent benign lesions. We have performed this procedure in two patients with ductal adenocarcinoma who could not tolerate a long surgical procedure, and the tumor recurred

3 and 6 mo after surgery in these patients. However, no recurrence was observed in our current series of patients with benign and low malignant potential lesions. Similarly, Adham *et al*[9] reported no recurrence in 50 patients with non-invasive lesions who underwent MSP. The highest frequency of tumor recurrence was found in Sauvanet *et al*[7] review in which four of 53 patients developed recurrence. We believe that providing an adequate tumor-free margin is necessary to avoid recurrence, even in benign and low malignant potential lesions.

In conclusion, MSP is a safe and organ-preserving option for benign or low-grade malignant lesions in the neck and proximal body of the pancreas. MSP offers naturally better long-term preservation of pancreatic exocrine and endocrine functions.

COMMENTS

Background

Whether patients with focal pancreatic lesions of benign or low-grade malignant pathology should be treated by middle segmental pancreatectomy (MSP) rather than by classic procedures, such as pancreaticoduodenectomy (PD) and extended distal pancreatectomy (EDP), is controversial. This study evaluated the feasibility and safety of MSP compared with PD and EDP.

Research frontiers

Clinically, surgical treatment for benign or low-grade malignant lesions of the pancreatic neck and body is often performed using 'traditional' procedures such as PD or EDP. However, these approaches result in a significant and unnecessary loss of normal pancreatic parenchyma with subsequent impairment of exocrine and endocrine functions. In the surgical treatment for benign or low-grade malignant lesions of the pancreatic neck and body, the research hotspot is how to ensure the perioperative safety and improve the long-term effects, including the preservation of pancreatic endocrine and exocrine function.

Innovations and breakthroughs

MSP has increasingly been applied for some lesions, including chronic pancreatitis, and benign and borderline lesions localized at the neck and body of pancreas. Several recent reports have compared the morbidity and quality of life in patients with chronic pancreatitis, and benign and low-grade malignant pancreatic tumors after MSP or traditional surgical procedures. The study focuses not only on the long-term effects, but also on the perioperative safety and the early postoperative patients' nutritional status after MSP. Compared with PD or EDP, MSP provided better nutritional status and postoperative preservation of pancreatic exocrine and endocrine functions.

Applications

MSP is a safe and organ-preserving option for benign or low-grade malignant lesions in the neck and proximal body of the pancreas.

Terminology

MSP: The head and tail of the pancreas were preserved, only the middle pancreas was removed when the lesions were located in the neck and proximal body of the pancreas.

Peer review

This is an interesting study that evaluated the feasibility and safety of MSP compared with PD and EDP. The results suggest that MSP is a safe and organ-preserving option for appropriate lesions in the neck and proximal body of the pancreas. MSP also provided better postoperative preservation of pancreatic exocrine and endocrine functions.

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