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ORIGINAL ARTICLE

Retrospective Study

Single center experience in selecting the laparoscopic Frey procedure for chronic pancreatitis

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Abstract

AIM: To share our experience regarding the laparoscopic Frey procedure for chronic pancreatitis (CP) and patient selection.

METHODS: All consecutive patients undergoing duodenum-preserving pancreatic head resection from July 2013 to July 2014 were reviewed and those undergoing the Frey procedure for CP were included in this study. Data on age, gender, body mass index (BMI), American Society of Anesthesiologists score, imaging findings, inflammatory index (white blood cells, interleukin (IL)-6, and C-reaction protein), visual analogue score score during hospitalization and outpatient visit, history of CP, operative time, estimated blood loss, and postoperative data (postoperative mortality and morbidity, postoperative length of hospital stay) were obtained for patients undergoing laparoscopic surgery. The open surgery cases in this study were analyzed for risk factors related to extensive bleeding, which was the major reason for conversion during the laparoscopic procedure. Age, gender, etiology, imaging findings, amylase level, complications due to pancreatitis, functional insufficiency, and history of CP were assessed in these patients.

RESULTS: Nine laparoscopic and 37 open Frey procedures were analyzed. Of the 46 patients, 39 were male (85%) and seven were female (16%). The etiology of CP was alcohol in 32 patients (70%) and idiopathic in 14 patients (30%). Stones were found in 38 patients (83%). An inflammatory mass was found in five patients (11%). The time from diagnosis of CP to the Frey procedure was 39 ± 19 (9-85) mo. The BMI of patients in the laparoscopic group was 20.4 ± 1.7 (17.8-22.4) kg/m^2 and was 20.6 ± 2.9 (15.4-27.7) kg/m^2 in the open group. All patients required analgesic medication for abdominal pain. Frequent acute pancreatitis or severe abdominal pain due to acute exacerbation occurred in 20 patients (43%). Pre-operative complications due to pancreatitis were observed in 18 patients (39%). Pancreatic functional insufficiency was observed in 14 patients (30%). Two laparoscopic patients (2/9) were converted. In seven successful laparoscopic cases, the mean operative time was 323 ± 29 (290-370) min. Estimated intra-operative

blood loss was 57 ± 14 (40-80) mL. One patient had a postoperative complication, and no mortality was observed. Postoperative hospital stay was 7 ± 2 (5-11) d. Multiple linear regression analysis of 37 open Frey procedures showed that an inflammatory mass ($P <$ 0.001) and acute exacerbation ($P <$ 0.001) were risk factors for intra-operative blood loss.

CONCLUSION: The laparoscopic Frey procedure for CP is feasible but only suitable in carefully selected patients.

Key words: Chronic pancreatitis; Frey procedure; Laparoscopic surgery; Surgical outcome; Pain

Core tip: The Frey procedure is an effective treatment for the relief of pain in chronic pancreatitis. Although the open Frey procedure is well described, the laparoscopic Frey procedure is rarely reported in the literature. Here, we share our experience with nine of these cases and discuss reasons for procedural failure. In addition, we describe the criteria for candidate selection and the results from a data review of open Frey cases.

INTRODUCTION

Chronic pancreatitis (CP) is a benign inflammatory disease characterized by the progressive conversion of pancreatic parenchyma to fibrous tissue. For the majority of CP patients, pain is the decisive symptom, and it causes much discomfort in their daily life. The management of CP is challenging, and most patients remain symptomatic despite medical therapy. When medical management fails, the next step is usually endoscopic interventions. Surgical intervention is the last resort when other treatments have failed, the severity of disease has progressed substantially, and pain is unmanageable.

Endoscopic therapy comprises pancreatic and biliary sphincterotomy, stricture dilation and stenting, stone extraction, and lithotripsy. However, not all patients are fit for endoscopic therapy. This approach requires careful patient selection and detailed evaluation of the pancreatic duct anatomy[1]. In fact, many patients choose endoscopic therapy, which is unsuitable, instead of surgical intervention, as it is minimally invasive. Surgical interventions seem to improve pain control[2,3], and it is necessary to develop a minimally invasive approach for surgical intervention in patients with CP.

In 2013, we performed the laparoscopic Frey procedure in selected patients with CP. In the beginning, we found it difficult due to the high rate of conversion because of extensive bleeding. Here, we summarize the outcome of nine laparoscopic cases and analyze the data for risk factors related to extensive bleeding in 37 CP consecutive patients.

MATERIALS AND METHODS

This is a retrospective study of the Frey procedure for CP. The outcome of laparoscopic cases were summarized, and open cases in this study were analyzed for risk factors related to extensive bleeding, which was the major reason for conversion during the laparoscopic procedure. After Institutional Review Board approval, a retrospective review of our database was performed for all consecutive patients undergoing duodenum-preserving pancreatic head resection (DPPHR) from July 2013 to July 2014, at West China Hospital, Sichuan, China. Patients who underwent the Frey procedure for CP were included in the present study. Indications for the Frey procedure included unmanageable pain after medical or endoscopic therapy, suspected malignant lesion, and stones in the distal pancreatic duct. Patients without malignant lesions were considered for the laparoscopic approach, and the Frey procedure was carried out by surgeons with substantial experience with total laparoscopic pancreaticoduodenectomy (PD) (> 20 cases) and significant experience in the open Frey procedure. Patients with malignant disease, which was proven during or after surgery, were excluded. Laparoscopic cases were described in this study and summarized for a single experience. Data on the laparoscopic cases, including age, gender, body mass index (BMI), American Society of Anesthesiologists score, imaging findings, inflammatory index [white blood cells, interleukin (IL)-6 and C-reaction protein (CRP)], visual analogue score (VAS) score during hospitalization and outpatient visit, history of CP, operative time, estimated blood loss, and postoperative data (postoperative mortality and morbidity, postoperative length of hospital stay) were obtained. The risk factors related to extensive intra-operative bleeding were analyzed in the open cases and included age, gender, etiology, imaging findings, level of amylase, complications due to pancreatitis, functional insufficiency, and history of CP.

Technique

The patients were placed in the modified lithotomy reverse Trendelenburg position with thighs parallel to the ground. The operating surgeon stood between the legs of the patient. The camera surgeon stood
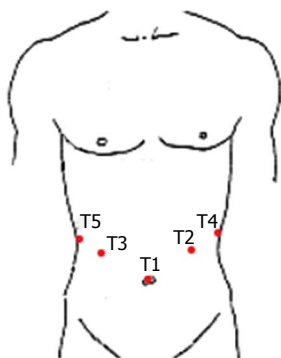
Figure 1 Placement of the 5 ports. T1: 12 mm telescope trocar in the navel; T2: 12 mm trocar along the left midclavear lines; T3: 12-mm trocar along the right midclavear lines; T4: 5 mm trocar along the left anterior axillary line; T5: 5 mm trocar along the right anterior axillary line.
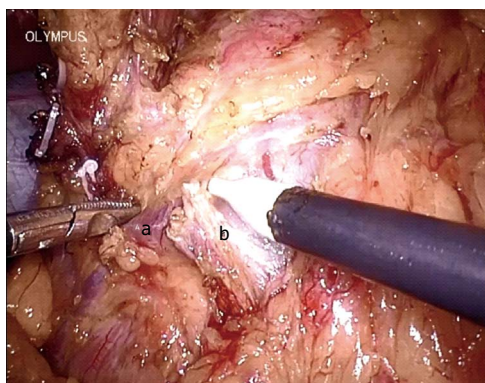

Figure 3 Resection of the branches of the gastrocolic trunk to expose the whole pancreatic head.

Figure 2 Skeletonized gastrocolic trunk and its branches. a: Anterior superior pancreaticoduodenal vein; b: Right colic vein.
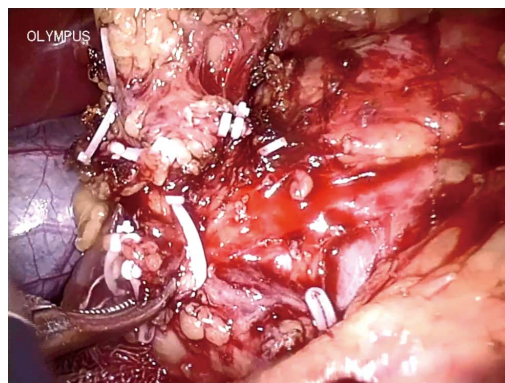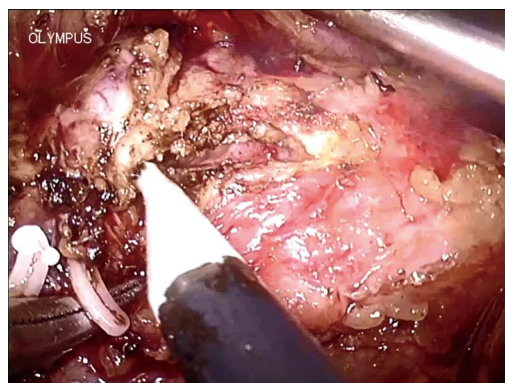

Figure 4 The pancreatic duct was opened longitudinally using the electrosurgical hook.

on the right side of the patient and two assistant surgeons were on the left and right side of the patient, respectively. The port positions are shown in Figure 1. Five trocars were used: a 12 mm telescope trocar in the navel (T1); two 12 mm trocars along the left (T2) and right (T3) midclavear lines, lateral to the rectus muscles, 2 cm above T1; two 5 mm trocars on the left and right side, along the left (T4) and right (T5) anterior axillary line.

The gastrocolic omentum was mobilized to gain entry to the lesser sac. The gastrohepatic omentum was opened to visualize the caudate lobe. The stomach was hung using a urinary catheter and fixed beneath the xiphoid process. The gastroduodenal artery was clipped with white locking plastic vascular clips and then resected. Conversion was considered if it was difficult to find the gastroduodenal artery due to severe inflammation around the pancreas. The gastrocolic trunk and its branches were skeletonized, and then the branches were resected to expose the whole pancreatic head (Figures 2 and 3). Intra-operative ultrasound was used to locate the main pancreatic duct and the extent of stones. The pancreatic duct was opened longitudinally using an electrosurgical hook (Figure 4). Large ductal stones were extracted while

opening the duct distally and proximally (Figure 5). The parenchyma of the pancreatic head with a depth to the posterior wall of the Wirsung duct was excavated using a harmonic scalpel (Ethicon Endo-Surgery, Johnson & Johnson Company, New Brunswick, NJ, United States), preserving parenchyma 0.5 cm wide close to the duodenum to prevent damage to the biliary duct in pancreatic parenchyma (Figure 6). The most difficult procedure using the laparoscope was finding the posterior wall of the Wirsung duct. It is advised that the section of the pancreatic parenchyma near the duodenum should be identified, which looks like a dilated orifice. This is the landmark that can indicate that enough of the pancreatic head tissue has been excavated. Usually, this is very difficult to perform even in open surgery, especially in patients with an enlarged pancreatic head. If this is not found, the depth of excavation should exceed the Santorini duct. Stones in the uncinatus process should be excavated. The resected pancreatic tissue was then sent for frozen section examination. Intra-operative ultrasound was then used again to identify residual stones in small branch ducts. All stones visible to the naked eye were removed.

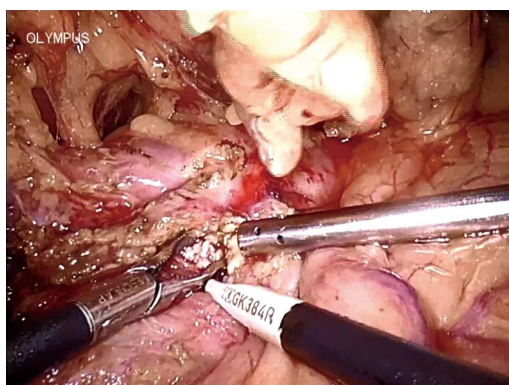The transverse mesocolon was raised cephalad

Figure 5 Large ductal stones are extracted while opening the duct distally and proximally.

Figure 7 One layer side-to-side pancreaticojejunostomy completed with interrupted sutures.
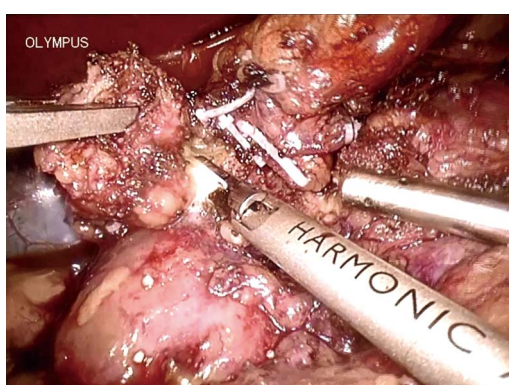

Figure 6 The parenchyma of the pancreatic head is excavated using a harmonic scalpel.

to identify the ligament of Treitz, and the pancreatic limb was measured to 40 cm. The small bowel was cut using an endolinear cutter (Ethicon Endo-Surgery, Johnson & Johnson Company). The Roux limb was marked and measured 40-60 cm according to the length of the opened pancreatic duct to allow tension-free retrocolic positioning to the lesser sac. A stapled side-to-side jejunojejunostomy was created using the endolinear cutter. The mesenteric defect was closed to prevent a potential internal hernia.

Careful staunching of bleeding was performed before pancreaticojejunostomy. The bowel was opened longitudinally and a one layer side-to-side pancreaticojejunostomy was completed with interrupted sutures (Figure 7). A drain was then placed beside the anastomosis.

Statistical analysis
All data are expressed as mean ± standard error of the mean (SEM). Multiple linear regression analysis was used to discriminate risk factors related to operative blood loss. For all analyses, $P < 0.05$ was considered significant. All analyses were performed using SPSS version 18.0 software (SPSS Company, Chicago, IL, United States).

RESULTS
Fifty-seven patients underwent DPPHR from July 2013 to July 2014. Nine patients underwent DPPHR for low malignant tumors and were excluded. Two patients were excluded due to malignant lesions confirmed after surgery. In total, 46 patients were included in this study. The laparoscopic Frey procedure was performed by one surgeon in nine patients with a mean age of 50 years. These nine patients were not suitable for endoscopic management during pre-surgery assessment, eight due to stones in the distal part of the pancreatic duct and one due to an inflammatory lesion in the pancreatic head. The open Frey procedure was performed by different surgeons in 37 patients with a mean age of 45 years.

Of these 46 patients, 39 were male (85%) and seven were female (16%). The etiology of CP was alcohol in 32 patients (70%) and idiopathic in 14 patients (30%). Stones were found in 38 patients (83%). An inflammatory mass was found in five patients (11%). The time from diagnosis of CP to the Frey procedure was 39 ± 19 (9-85) mo. BMI of patients in the laparoscopic group was 20.4 ± 1.7 (17.8-22.4) kg/m^2 and was 20.6 ± 2.9 (15.4-27.7) kg/m^2 in the open group. All patients required analgesic medication due to abdominal pain. Frequent acute pancreatitis or severe abdominal pain due to acute exacerbation occurred in 20 patients (43%). Pre-operative complications due to pancreatitis were observed in 18 patients (39%). Pancreatic functional insufficiency was observed in 14 patients (30%). The mean pre-operative VAS in the laparoscopic patients was 7.1 ± 0.8 (6-8) before surgery and was 1.1 ± 0.9 (0-2) at the 3 mo follow-up period. The demographics and peri-operative characteristics of the patients are listed in Tables 1 and 2.

Two patients were converted in the laparoscopic group. Seven patients were treated successfully with a mean operative time of 323 ± 29 (290-370) min. Estimated intra-operative blood loss (EBL) was

Table 1 Demographics and peri-operative characteristics of nine laparoscopic patients

Patient	Sex	Age (yr)	BMI (kg/m^2)	Etiology	ASA	VAS	Pancreatitis	M-ANNHEIM	M-ANNHEIM score
1	Male	54	17.8	Alcohol	II	6	No	IIb	9
2	Male	44	20.4	Idiopathic	II	7	No	Ib	7
3	Male	60	18.5	Alcohol	III	7	No	IIb	14
4	Male	52	21.4	Alcohol	III	8	Yes	Ib	10
5	Male	56	19.3	Alcohol	II	7	No	IIb	14
6	Male	46	22.1	Alcohol	II	6	No	Ib	9
7	Male	42	19.7	Alcohol	II	8	No	Ib	9
8	Male	56	21.8	Idiopathic	III	8	No	IIb	14
9	Male	36	22.4	Idiopathic	II	7	No	Ib	9
	Amylase	WBC (× 10^9/L)	CRP	IL-6	Pancreatic duct (mm)	Stones	Inflammatory mass	History of CP (mo)	
1	68	5.1	No	No	8	Yes	No	62	
2	48	6.14	No	No	5	No	Yes	42	
3	47	4.11	No	No	10	Yes	No	85	
4	101	5.3	No	No	8	Yes	No	32	
5	78	6.84	No	No	9	Yes	No	76	
6	53	4.7	No	No	8	Yes	No	47	
7	55	5.1	No	No	9	Yes	No	56	
8	66	6.44	No	No	11	Yes	No	80	
9	44	5.3	No	No	9	Yes	No	32	

M-ANNHEIM: A classification system for chronic pancreatitis, Ib indicates recurrent or chronic abdominal pain without pancreatic insufficiency, IIb indicates isolated exocrine (or endocrine) pancreatic insufficiency with pain; ASA: American Society of Anesthesiologists; VAS: Visual analogue score; WBC: White blood cell; IL: Interleukin; CRP: C-reactive protein; CP: Chronic pancreatitis.

Table 2 Demographics and peri-operative characteristics of 37 open surgery patients

Male/Female	30/7
Age (yr)	45 ± 11 (27-70)
Body mass index	20.6 ± 2.9 (15.4-27.7)
Etiology	
Alcohol	26 (70)
Idiopathic	11 (30)
Pancreatic stone	30 (81)
Pancreatic mass	4 (11)
Acute exacerbation	19 (51)
History of diagnosis of CP (mo)	34 ± 17 (9-85)
Amylase elevated over 3 times	4 (11)
Complications due to pancreatitis	
Pancreatic pseudocyst	12 (32)
Bile duct stenosis	5 (14)
PPH	1 (3)
Functional insufficiency	
IGT/Diabetes mellitus	10 (27)
Malabsorption	1 (3)

CP: Chronic pancreatitis; PPH: Postpancreatectomy hemorrhage; IGT: Impaired glucose tolerance.

57 ± 14 (40-80) mL. Postoperative complications occurred in one patient who had postpancreatectomy hemorrhage (PPH) and recovered without treatment. No mortality was observed in the laparoscopic group. Postoperative hospital stay was 7 ± 2 (5-11) d (Table 3). Postoperative morbidity was 11% (4/37) in the open group, No mortality was observed. EBL was 293 ± 247 (70-1100) mL. Multiple linear regression analysis of the 37 open Frey procedures showed that an inflammatory mass ($P < 0.001$) and acute exacerbation ($P < 0.001$) were risk factors for intra-operative blood loss (Table 4) among the risk factors listed in Table 2.

DISCUSSION

The mechanism of pain in CP remains unclear and is debated[4,5]. Several hypotheses have been proposed, and it is thought that pain is probably the result of a combination of these concepts. They comprise intraductal and interstitial hypertension and neurogenic and central sensitization theories[6,7]. It has been shown than simple drainage procedures do not ensure sufficient pain relief in patients with enlargement of the pancreatic head[8,9]. Therefore, resection of the pancreatic head should be a central feature of any surgical procedure. The Frey procedure improves the overall pancreatic ductal drainage by decompressing both the main and small ducts in the pancreatic head. Moreover, most of the pancreatic head, which is thought to be the "pacemaker" of pain, is removed during this procedure[10]. Randomized controlled trials have demonstrated that PD is effective in controlling CP symptoms. However, the high morbidity and mortality associated with this procedure are considered preventable in this benign disease[11,12]. The 15 year long-term effectiveness of the Frey procedure was comparable to pylorus-preserving PD and resulted in permanent pain control. However, quality of life was better after the Frey procedure with regard to physical status[13]. When comparing the Beger procedure with the Frey procedure, the latter procedure was associated with fewer complications and equivalent pain relief, functional insufficiency, and quality of

Table 3 Postoperative characteristics of nine laparoscopic Frey procedures

Patient	Converted	Operative time (min)	EBL (mL)	Complications	Mortality	LOS	EBL (3-mo)
1	No	370	50	No	No	5	2
2	Yes	-	-	-	-	-	-
3	No	290	60	No	No	7	1
4	No	-	-	-	-	-	-
5	No	310	50	PPH (grade A)	No	11	0
6	No	330	70	No	No	6	2
7	No	350	50	No	No	7	2
8	No	300	40	No	No	5	0
9	No	310	80	No	No	6	1

PPH: Postpancreatectomy hemorrhage; EBL: Estimated intra-operative blood loss.

Table 4 Results of multiple linear regression analysis of 37 open Frey procedures

Risk factors	Standard regression coefficient	P value
Inflammatory mass	0.559	0.00
Acute exacerbation	0.508	0.00

life[10,14,15].

CP is a common inflammatory disease with the principal symptom of chronic pain, which can reduce quality of life and results in the inability to work. A 5-fold increase in mortality in CP patients was observed compared with a population without CP[16]. Despite improvements in conservative, interventional, and surgical procedures, the treatment of CP remains challenging[17]. Medical treatment is currently recommended first in order to avoid surgery. Surgical intervention is the last resort when other treatments have failed and the severity of the disease has increased substantially such that pain is unmanageable. At the end of the last century, several studies demonstrated that early surgical pancreatic drainage was beneficial for pain control and preservation of function[18-20]. A multicenter randomized controlled trial is now in progress by the Dutch Pancreatitis Study Group to evaluate the benefits, risks, and costs of early surgical intervention. Endoscopic treatment is less invasive than surgical intervention and is preferred by patients. Endoscopic therapy aims to remove obstructions (strictures or stones) in the main pancreatic duct. This approach requires careful patient selection and detailed evaluation of the pancreatic duct anatomy. In a retrospective analysis of 1000 patients treated with endoscopy, approximately 25% of patients underwent surgery for failure of pain relief after therapy[21]. Moreover, surgery has been shown to be superior to endoscopic treatment in two main randomized controlled trials[3,22]. However, some unsuitable patients choose endoscopic treatment as they are afraid of surgical intervention.

Laparoscopic surgery is now routinely performed for many pancreatic diseases, with the exception of CP[23-25]. We performed our first laparoscopic Frey procedure for CP in 2013. To date, we have carefully selected nine patients for the laparoscopic Frey procedure. Seven procedures were successful, while two procedures were converted to open surgery. Patient 2 was converted because we were unable to find the pancreatic duct, although intra-operative ultrasound identified segmental dilation of the main pancreatic duct. The pancreatic duct is the mark of depth for excavation during laparoscopy. Opening the pancreatic duct longitudinally is an important procedure for drainage during the Frey procedure. The pancreatic parenchyma is very thick, and the pancreatic duct is about 5 mm on pre-operative computed tomography (CT). Thus, a pancreatic duct width of over 8 mm was one of our criteria for laparoscopic candidates on the basis of our own experience. All patients met this criterion, and their pancreatic ducts were easily found during laparoscopy. Patient 4 was converted to the open procedure due to severe inflammatory pancreatic parenchyma. Blood oozed from the pancreas when the pancreatic head parenchyma was excavated. It was difficult to staunch the bleeding with electrocautery or suture during laparoscopy. Therefore, we immediately converted to the open procedure to avoid unmanageable bleeding during excavation of the pancreatic head.

The laparoscopic Frey procedure requires careful patient selection. The degree of pancreatic inflammation, which can lead to unmanageable bleeding, is the key factor in the success of this procedure. However, it is very difficult to judge how severe the inflammation is before surgery. We found that indicators of systemic inflammation, such as white blood cells, IL-6, and CRP in blood samples, were not sensitive for pancreatic inflammation. Patient 4 had a history of acute pancreatitis with two episodes per year in recent years. The last episode occurred 6 mo before surgery. We selected this patient for the laparoscopic Frey procedure because the level of amylase was normal and no sign of acute inflammation was seen on the CT image. Unfortunately, the patient was converted to the open procedure due to severe peri-pancreatic inflammation.

In order to identify risk factors for uncontrolled intra-operative bleeding, we obtained peri-operative data of 37 patients during the open Frey procedure.

Pre-operative factors, including age, BMI, gender, etiology, pancreatic stones, pancreatic mass, history of CP, amylase level, complications due to acute pancreatitis, and functional insufficiency, were evaluated in a multiple linear regression analysis. The results of multiple linear regression analysis showed that a pancreatic inflammatory mass and pre-operative acute exacerbation were related to the volume of intra-operative blood loss. These two factors usually indicate severe inflammation in the pancreatic head. These results were comparable to the findings during nine laparoscopic procedures. Although complications due to acute pancreatitis were not risk factors in our study, they were difficult to manage under laparoscopy. Thus, we chose the open procedure for patients with complications due to acute pancreatitis.

As laboratory examination can not indicate the degree of peri-pancreatic inflammation, CT imaging may be more suitable. In our successful cases, we found that fibrosis and calcification, which were easily observed on CT images, usually meant manageable bleeding during pancreatic excavation. This also indicated a low incidence of pancreatic fistula after surgery. According to a published report, the majority of pancreatic calcifications (56%) resulted in relapsing pain episodes[26].

The extent of excavation of pancreatic head parenchyma is questionable. The original Frey procedure involved coring out the anterior and posterior parenchyma of the main pancreatic duct in the pancreatic head and resecting as much of the parenchyma as possible, leaving only the posterior capsule of the head. We found this difficult to achieve during laparoscopy. The depth of parenchyma lacks an anatomic landmark. Injury to the common bile duct or portal vein frequently occurred during the original Frey procedure[27]. This is riskier during laparoscopy, as the main pancreatic duct is the only anatomic landmark during laparoscopy. Therefore, it is very important to open the main pancreatic duct during laparoscopy. In order to avoid injury to the common bile duct, we preserved parenchyma 0.5 cm wide close to the duodenum. We preserved parenchyma posterior to the main duct in the pancreatic head as much as possible to prevent injury to the superior mesenteric vein. The anatomic landmark for the depth of parenchyma excavated is the posterior wall of the Wirsung duct, similar to the modified Frey procedure[27]. It is difficult to find the posterior wall of the Wirsung duct during laparoscopy. It is advisable to find the section of the pancreatic parenchyma near the duodenum that looks like a dilated orifice. However, it is usually very difficult to do that even during open surgery, especially in patients with an enlarged pancreatic head. If it cannot be found, the depth for excavation should exceed the Santorini duct. Although our extent of resection is smaller than the ordinary Frey procedure, the VAS score decreased quickly. All seven patients showed significantly lower VAS score at 3 mo after surgery compared with before surgery. Sakata *et al*[28] advocated a "minimum Frey procedure" with limited resection of the anterior part of the pancreas head with a longitudinal pancreaticojejunostomy. These authors compared the effectiveness of the minimum Frey procedure with the original Frey procedure in terms of pain relief and preservation of endocrine and exocrine function. In the present study, the VAS score in laparoscopic patients decreased significantly at the 3 mo follow-up period. However, our reduced extent of excavation may not be suitable for candidates with an inflammatory mass in the pancreas head.

In the multiple linear regression analysis of 37 open Frey procedures, an inflammatory mass was a risk factor for intra-operative blood loss. The extent of excavation of the pancreatic head described above may not be enough for candidates with an inflammatory mass in the pancreatic head. Taking into consideration the two risk factors for massive bleeding and insufficient excavation, we think candidates with an inflammatory mass should undergo the open procedure.

Taking into account the outcomes of nine laparoscopic cases and the results of multiple linear regression analysis of 37 open cases, we suggest that the laparoscopic Frey procedure may only be suitable for patients with an obvious dilated pancreatic duct, an enlarged pancreatic head on CT, and an absence of an inflammatory mass, exacerbation, and complications due to pancreatitis.

In conclusion, the laparoscopic Frey procedure is feasible, but suitable only in carefully selected patients. It may only be suitable for patients with an obvious dilated pancreatic duct and enlarged pancreatic head on CT. If acute exacerbation, inflammatory mass, or complications due to pancreatitis exist before surgery, the laparoscopic procedure should not be considered.

COMMENTS

Background
Chronic pancreatitis (CP) is a benign inflammatory disease, characterized by the progressive conversion of pancreatic parenchyma to fibrous tissue. Patients with CP can have pain that reduces the quality of life. Surgical intervention is the last resort when other treatments have failed, the severity of disease has increased substantially, and pain is unmanageable. Here, the authors reported their experience regarding the laparoscopic Frey procedure for CP.

Research frontiers
Laparoscopic surgery is now routinely performed for many pancreatic diseases, with the exception of CP. There are few published studies on the use of this procedure for CP. Here, we summarize the outcome of nine cases using this procedure, discuss why this laparoscopic procedure is difficult in patients with CP, and how to select the right candidates.

Innovations and breakthroughs
The management of CP is challenging, and most patients remain symptomatic despite medical therapy. The endoscopic approach requires careful patient selection and detailed evaluation of the pancreatic duct anatomy. As one of the surgical therapies used for CP, the Frey procedure can provide permanent pain control. Laparoscopic surgery is now routinely performed for many pancreatic diseases, with the exception of CP. However, the laparoscopic

Frey procedure is rarely reported. The authors reported nine patients who underwent the laparoscopic Frey procedure, including seven successful cases, and highlighted the surgical process and the key points. According to their experience, conversion to the open procedure was usually due to severe peri-pancreatic inflammation, which could lead to uncontrolled bleeding during laparoscopy, or undetectable pancreatic duct. An inflammatory mass on CT and acute exacerbation were pre-operative risk factors for intra-operative blood loss. These findings were helpful in the pre-operative selection of candidates for laparoscopy.

Applications

This study shows that the laparoscopic Frey procedure is feasible, but only suitable for carefully selected patients. It may only be suitable for patients with an obvious dilated pancreatic duct and enlarged pancreatic head on CT. If acute exacerbation, inflammatory mass, or complications due to pancreatitis exist before surgery, the laparoscopic procedure should not be considered.

Terminology

The Frey procedure was first described in 1987 by Frey *et al* and combines partial resection of the head of the pancreas (resection) with lateral pancreatico-jejunostomy (drainage). The rationale for this hybrid procedure is that it improves the overall pancreatic ductal drainage by decompressing both the duct of Santorini and ducts in the uncinate process.

Peer-review

The true interest of this original paper is the scarce number of laparoscopic Frey procedures, with their difficulties and complications, reported in the literature. However, the short follow-up of the postsurgical evolution of patients makes it difficult to compare the evolution of the patient's pain after the laparoscopic approach compared with the standard Frey open procedure or with the results published in the literature.

REFERENCES

1   **Kwek AB**, Ang TL, Maydeo A. Current status of endotherapy for chronic pancreatitis. *Singapore Med J* 2014; **55**: 613-620 [PMID: 25630314]

2   **Cahen DL**, Gouma DJ, Nio Y, Rauws EA, Boermeester MA, Busch OR, Stoker J, Laméris JS, Dijkgraaf MG, Huibregtse K, Bruno MJ. [Surgical drainage of the pancreatic duct in patients with chronic pancreatitis is more effective than endoscopic drainage: randomized trial]. *Ned Tijdschr Geneeskd* 2007; **151**: 2624-2630 [PMID: 18161265]

3   **Díte P**, Ruzicka M, Zboril V, Novotný I. A prospective, randomized trial comparing endoscopic and surgical therapy for chronic pancreatitis. *Endoscopy* 2003; **35**: 553-558 [PMID: 12822088 DOI: 10.1055/s-2003-40237]

4   **Demir IE**, Tieftrunk E, Maak M, Friess H, Ceyhan GO. Pain mechanisms in chronic pancreatitis: of a master and his fire. *Langenbecks Arch Surg* 2011; **396**: 151-160 [PMID: 21153480 DOI: 10.1007/s00423-010-0731-1]

5   **Sakorafas GH**, Tsiotou AG, Peros G. Mechanisms and natural history of pain in chronic pancreatitis: a surgical perspective. *J Clin Gastroenterol* 2007; **41**: 689-699 [PMID: 17667054 DOI: 10.1097/MCG.0b013e3180301baf]

6   **Bouwense SA**, Ahmed Ali U, ten Broek RP, Issa Y, van Eijck CH, Wilder-Smith OH, van Goor H. Altered central pain processing after pancreatic surgery for chronic pancreatitis. *Br J Surg* 2013; **100**: 1797-1804 [PMID: 24227367 DOI: 10.1002/bjs.9322]

7   **Poulsen JL**, Olesen SS, Malver LP, Frøkjær JB, Drewes AM. Pain and chronic pancreatitis: a complex interplay of multiple mechanisms. *World J Gastroenterol* 2013; **19**: 7282-7291 [PMID: 24259959 DOI: 10.3748/wjg.v19.i42.7282]

8   **Bachmann K**, Izbicki JR, Yekebas EF. Chronic pancreatitis: modern surgical management. *Langenbecks Arch Surg* 2011; **396**: 139-149 [PMID: 21174215 DOI: 10.1007/s00423-010-0732-0]

9   **Izbicki JR**, Bloechle C, Knoefel WT, Rogiers X, Kuechler T. Surgical treatment of chronic pancreatitis and quality of life after operation. *Surg Clin North Am* 1999; **79**: 913-944 [PMID: 10470335]

10 **Bachmann K**, Tomkoetter L, Erbes J, Hofmann B, Reeh M, Perez D, Vashist Y, Bockhorn M, Izbicki JR, Mann O. Beger and Frey procedures for treatment of chronic pancreatitis: comparison of outcomes at 16-year follow-up. *J Am Coll Surg* 2014; **219**: 208-216 [PMID: 24880955 DOI: 10.1016/j.jamcollsurg.2014.03.040]

11 **Izbicki JR**, Bloechle C, Broering DC, Knoefel WT, Kuechler T, Broelsch CE. Extended drainage versus resection in surgery for chronic pancreatitis: a prospective randomized trial comparing the longitudinal pancreaticojejunostomy combined with local pancreatic head excision with the pylorus-preserving pancreatoduodenectomy. *Ann Surg* 1998; **228**: 771-779 [PMID: 9860476]

12 **McClaine RJ**, Lowy AM, Matthews JB, Schmulewitz N, Sussman JJ, Ingraham AM, Ahmad SA. A comparison of pancreaticoduodenectomy and duodenum-preserving head resection for the treatment of chronic pancreatitis. *HPB (Oxford)* 2009; **11**: 677-683 [PMID: 20495636 DOI: 10.1111/j.1477-2574.2009.00118.x]

13 **Bachmann K**, Tomkoetter L, Kutup A, Erbes J, Vashist Y, Mann O, Bockhorn M, Izbicki JR. Is the Whipple procedure harmful for long-term outcome in treatment of chronic pancreatitis? 15-years follow-up comparing the outcome after pylorus-preserving pancreatoduodenectomy and Frey procedure in chronic pancreatitis. *Ann Surg* 2013; **258**: 815-820; discussion 820-821 [PMID: 24096767 DOI: 10.1097/SLA.0b013e3182a655a8]

14 **Keck T**, Wellner UF, Riediger H, Adam U, Sick O, Hopt UT, Makowiec F. Long-term outcome after 92 duodenum-preserving pancreatic head resections for chronic pancreatitis: comparison of Beger and Frey procedures. *J Gastrointest Surg* 2010; **14**: 549-556 [PMID: 20033344 DOI: 10.1007/s11605-009-1119-9]

15 **Strate T**, Taherpour Z, Bloechle C, Mann O, Bruhn JP, Schneider C, Kuechler T, Yekebas E, Izbicki JR. Long-term follow-up of a randomized trial comparing the beger and frey procedures for patients suffering from chronic pancreatitis. *Ann Surg* 2005; **241**: 591-598 [PMID: 15798460]

16 **Bang UC**, Benfield T, Hyldstrup L, Bendtsen F, Beck Jensen JE. Mortality, cancer, and comorbidities associated with chronic pancreatitis: a Danish nationwide matched-cohort study. *Gastroenterology* 2014; **146**: 989-994 [PMID: 24389306 DOI: 10.1053/j.gastro.2013.12.033]

17 **Knoefel WT**, Eisenberger CF, Strate T, Izbicki JR. Optimizing surgical therapy for chronic pancreatitis. *Pancreatology* 2002; **2**: 379-384; discussion 385 [PMID: 12138226 DOI: 10.1159/000065085]

18 **Ihse I**, Borch K, Larsson J. Chronic pancreatitis: results of operations for relief of pain. *World J Surg* 1990; **14**: 53-58 [PMID: 2407038]

19 **Nealon WH**, Thompson JC. Progressive loss of pancreatic function in chronic pancreatitis is delayed by main pancreatic duct decompression. A longitudinal prospective analysis of the modified puestow procedure. *Ann Surg* 1993; **217**: 458-466; discussion 466-468 [PMID: 8489308]

20 **Nealon WH**, Townsend CM, Thompson JC. Operative drainage of the pancreatic duct delays functional impairment in patients with chronic pancreatitis. A prospective analysis. *Ann Surg* 1988; **208**: 321-329 [PMID: 3421756]

21 **Rösch T**, Daniel S, Scholz M, Huibregtse K, Smits M, Schneider T, Ell C, Haber G, Riemann JF, Jakobs R, Hintze R, Adler A, Neuhaus H, Zavoral M, Zavada F, Schusdziarra V, Soehendra N. Endoscopic treatment of chronic pancreatitis: a multicenter study of 1000 patients with long-term follow-up. *Endoscopy* 2002; **34**: 765-771 [PMID: 12244496 DOI: 10.1055/s-2002-34256]

22 **Cahen DL**, Gouma DJ, Nio Y, Rauws EA, Boermeester MA, Busch OR, Stoker J, Laméris JS, Dijkgraaf MG, Huibregtse K, Bruno MJ. Endoscopic versus surgical drainage of the pancreatic duct in chronic pancreatitis. *N Engl J Med* 2007; **356**: 676-684 [PMID: 17301298 DOI: 10.1056/NEJMoa060610]

23 **Palanivelu C**, Jani K, Senthilnathan P, Parthasarathi R, Rajapandian S, Madhankumar MV. Laparoscopic pancreaticoduodenectomy:

technique and outcomes. *J Am Coll Surg* 2007; **205**: 222-230 [PMID: 17660068 DOI: 10.1016/j.jamcollsurg.2007.04.004]

24   **Paniccia A**, Schulick RD, Edil BH. Total Laparoscopic Pancreaticoduodenectomy: A Single-Institutional Experience. *Ann Surg Oncol* 2015; Epub ahead of print [PMID: 25893407 DOI: 10.1245/s10434-015-4450-2]

25   **Kim EY**, You YK, Kim DG, Lee SH, Han JH, Park SK, Na GH, Hong TH. Dual-incision laparoscopic spleen-preserving distal pancreatectomy. *Ann Surg Treat Res* 2015; **88**: 174-177 [PMID: 25741499 DOI: 10.4174/astr.2015.88.3.174]

26   **Lankisch PG**, Löhr-Happe A, Otto J, Creutzfeldt W. Natural course in chronic pancreatitis. Pain, exocrine and endocrine pancreatic insufficiency and prognosis of the disease. *Digestion* 1993; **54**: 148-155 [PMID: 8359556]

27   **Frey CF**, Amikura K. Local resection of the head of the pancreas combined with longitudinal pancreaticojejunostomy in the management of patients with chronic pancreatitis. *Ann Surg* 1994; **220**: 492-504; discussion 504-507 [PMID: 7524454]

28   **Sakata N**, Egawa S, Motoi F, Goto M, Matsuno S, Katayose Y, Unno M. How much of the pancreatic head should we resect in Frey's procedure? *Surg Today* 2009; **39**: 120-127 [PMID: 19198989 DOI: 10.1007/s00595-008-3816-5]

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