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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

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Objective
To analyze the efficacy of extended drainage—that is, longitudinal pancreaticojejunostomy combined with local pancreatic head excision (LPJ-LPHE)—and pylorus-preserving pancreatoduodenectomy (PPPD) in terms of pain relief, control of complications arising from adjacent organs, and quality of life.

Summary Background Data
Based on the hypotheses of pain origin (ductal hypertension and perineural inflammatory infiltration), drainage and resection constitute the main principles of surgery for chronic pancreatitis.

Methods
Sixty-one patients were randomly allocated to either LPJ-LPHE (n = 31) or PPPD (n = 30). The interval between symptoms and surgery ranged from 12 months to 10 years (mean 5.1 years). In addition to routine pancreatic diagnostic workup, a multidimensional psychometric quality-of-life questionnaire and a pain score were used. Endocrine and exocrine functions were assessed in terms of oral glucose tolerance and serum concentrations of insulin, C-peptide, and HbA_{1c}, as well as fecal chymotrypsin and pancreolauryl testing. During a median follow-up of 24 months (range 12 to 36), patients were reassessed in the outpatient clinic.

Results
One patient died of cardiovascular failure in the LPJ-LPHE group (3.2%); there were no deaths in the PPPD group. Overall, the rate of in-hospital complications was 19.4% in the LPJ-LPHE group and 53.3% in the PPPD group, including delayed gastric emptying in 9 of 30 patients (30%; $p < 0.05$). Complications of adjacent organs were definitively resolved in 93.5% in the LPJ-LPHE group and in 100% in the PPPD group. The pain score decreased by 94% after LPJ-LPHE and by 95% after PPPD. Global quality of life improved by 71% in the LPJ-LPHE group and by 43% in the PPPD group ($p < 0.01$).

Conclusions
Both procedures are equally effective in terms of pain relief and definitive control of complications affecting adjacent organs, but extended drainage by LPJ-LPHE provides a better quality of life.

Exocrine and endocrine pancreatic insufficiency and recurrent episodes of abdominal pain are the characteristic clinical features of chronic pancreatitis. Severe pain is the leading cause of admission to the hospital, inability to work, early retirement, and addiction to analgesics in devastating conditions of chronic pancreatitis.[1] Like other therapeutic modalities, surgery addresses pain as the incapacitating symptom, although treatment options targeted at the cause are still lacking.

Based on experimental evidence and clinical experience, ductal and parenchymatous hypertension and neural alter-

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ations, in combination with extensive fibrosis, have been proposed as basic hypotheses for the pathogenesis of pain in chronic pancreatitis.[2–7] As a result of these theories of pain origin, drainage and resection have emerged as the main principles of surgery in chronic pancreatitis.

During the last decade, traditional resective procedures, such as classical partial pancreatoduodenectomy (Whipple procedure[8]) and pylorus-preserving pancreatoduodenectomy (PPPD; Traverso–Longmire procedure[9]), have been compared in prospective randomized trials with the duodenum-preserving resection of the head of the pancreas as described by Beger et al.[10] The gastroduodenal passage and common bile duct continuity-sparing procedure of Beger was found to be advantageous with regard to pain relief and preservation of exocrine and endocrine pancreatic function.[11,12]

Recently, we performed a prospective randomized comparison between longitudinal pancreaticojejunostomy combined with local pancreatic head excision (LPJ-LPHE; Frey procedure,[6,13] which is basically an extension of the traditional drainage procedure described by Partington and Rochelle[14]) and the duodenum-preserving resection of the head of the pancreas.[15] In this study, the extended drainage (Frey) procedure proved to be equally effective in terms of pain relief, control of complications arising from adjacent organs, preservation of exocrine and endocrine function, and, most importantly, improvement of quality of life. The rate of in-hospital complications was significantly less with the Frey procedure than with the Beger procedure.

However, to discover whether the extended drainage by LPJ-LPHE is a legitimate surgical alternative in the most severe conditions of chronic pancreatitis, the Frey procedure must meet the academic challenge of competing with a commonly accepted, traditional resection procedure. Therefore, we devised this prospective randomized study to compare LPJ-LPHE with PPPD in terms of improvement of quality of life, pain relief, and control of complications arising from adjacent organs.

PATIENTS AND METHODS

The protocol was approved by the Ethics and Research Committee of the Hamburg Medical Association. All patients were seen by a panel of gastroenterologists and surgeons who decided on the indication for surgery and on the patient's inclusion into the study.

Inclusion criteria were an inflammatory mass in the head of the pancreas (>35 mm in diameter), severe recurrent pain attacks (at least 1 per month requiring opiates), history of pain attacks for at least 1 year, or coexisting complications from adjacent organs (*e.g.*, common bile duct stenosis, duodenal stenosis). Disease-related exclusion criteria were chronic pancreatitis without involvement of the pancreatic head, small duct disease (maximal diameter of duct of Wirsung, 3 mm), pseudocysts without duct pathology, and portal vein thrombosis. Patient-related exclusion criteria were myocardial infarction within 6 months, detection of a malignant pancreatic tumor, and coexisting malignancy of other organs.

Since January 1995, 64 consecutive patients with chronic pancreatitis who were found eligible for the study were randomly allocated to either the extended drainage or the resection group. Three of these 64 patients (1 in the extended drainage group, 2 in the resection group) were excluded after entry because a pancreatic carcinoma was found during surgery on frozen-section analysis. Thus, 61 patients make up the study group (extended drainage group, n = 31; resection group, n = 30).

The median interval between symptoms and surgical intervention was 5 years (range 1 to 10 years). The etiology was alcohol overindulgence in 47 patients. In the remaining 14 patients, the etiology remained unknown, and pancreatitis was considered to be of idiopathic origin.

During workup and/or conservative treatment, the patients had undergone a median of four endoscopic retrograde cholangiopancreaticographies, excluding patients with duodenal stenosis (range 1 to 17). During a median period of 15 weeks, conservative treatment, including endoscopic drainage and extracorporeal shock wave lithotripsy, had failed to provide pain relief in 43 patients. The remaining 18 patients underwent surgery primarily because conservative treatment modalities were considered inappropriate.

Surgery was indicated because of recurrent intractable pain in all patients. There was no significant difference between the two groups with regard to age, sex, and distribution of pathologic findings (Table 1).

Patient Assessment

The routine diagnostic workup of all patients was performed as described previously.[15] Briefly, it included abdominal ultrasonography, helical abdominal computed tomographic (CT) scanning, angiography, and endoscopic retrograde cholangiopancreaticography, where technically feasible. It also included functional tests as outlined below.

An inflammatory mass in the head of the pancreas was visualized in all patients by abdominal sonography and CT scanning. The median pancreatic head diameter was 56 mm (range 41 to 126 mm), as assessed by helical CT scan.

Endoscopic retrograde pancreaticography revealed pancreatic duct lesions determined to be stage II in 17 and stage III in 44 patients, according to the Cambridge classification.[16]

Thirty-four patients had a common bile duct stenosis, demonstrated by endoscopic retrograde cholangiography and sonography. In five patients with recurrent emesis, duodenal stenosis was endoscopically shown. After 4 weeks of total parenteral nutrition, the duodenal obstruction had not resolved spontaneously, as demonstrated by hypotonic duodenography. In these patients, endoscopic retrograde cholangiopancreaticography could not be performed. In 13

Table 1. CLINICAL CHARACTERISTICS OF THE STUDY POPULATION*

	Extended Drainage Group (n = 31)	Resection Group (n = 30)
Age (yrs, mean ± SD)	43.1 ± 6.5	44.6 ± 5.3
Sex (m/f)	25/6	26/4
Etiology (no. of patients)		
ETOH	25	22
Idiopathic	6	8
Pain (for at least 12 months, no. of patients)	31	30
Time since onset of symptoms (yrs, mean ± SD)	5.5 ± 2.3	4.8 ± 2.6
Inflammatory mass in the pancreatic head (no. of patients)		
> 35 mm	5	5
> 50 mm	15	18
> 70 mm	11	7
Pseudocysts		
> 30 mm	11	13
> 50 mm	2	3
Ductal morphology (Cambridge classification; see ref. [16])†		
stage II	7	7
stage III	20	22
Common bile duct stenosis (no. of patients)	18	16
Segmental duodenal stenosis (no. of patients)	2	3
Segmental portal hypertension (no. of patients)	6	7
Loss of body weight (> 10%, no. of patients)	17	18
Diabetes mellitus (no. of patients)	9	8
Inability to work (> 6 months) (no. of patients)	26	24

* Both patient groups are comparable in terms of incidence of complications from adjacent organs, pancreatic morphology and clinical features.
† Excluding five patients with segmental duodenal stenosis, in which an endoscopic retrograde pancreteaticography could not be performed.
ETOH = ethyl alcohol

patients, angiography showed compression of the portal vein suggestive of segmental portal hypertension.

Exocrine pancreatic function was assessed by estimation of fecal chymotrypsin concentration (normal >40 μg/g feces, pathologic <40 μg/g feces)[17] and the pancreolauryl test (normal >30%, intermediate 20% to 30%, pathologic <20%)[18] (Table 2). Endocrine pancreatic function was assessed by the need to treat diabetes mellitus with diet modification, oral hypoglycemic agents, or insulin. Fasting serum insulin (normal <10 μE/ml, pathologic >10 μE/ml) and C-peptide levels (normal <0.7 to 3 ng/ml, pathologic >3 ng/ml), as well as HbA_{1c} concentrations (normal <4.5% to 6%, pathologic >6%), were also determined. In all patients who were not insulin-dependent, an oral glucose tolerance test was performed, and the results were classified as normal, impaired, or diabetes mellitus according to the criteria set forth by the 1985 WHO Study Group on Diabetes Mellitus[19] (Table 3).

Pain intensity was estimated employing a recently suggested pain scoring system that includes a visual analog scale, frequency of pain attacks, use of analgesic medication, and the time of disease-related inability to work (Table 4).[20] Median pain frequency was classified as several times (*i.e.*, at least three attacks) per week in 19 of 31 patients in the extended drainage group and 17 of 30 patients in the resection group. Daily pain was reported by 7 of 31 in the extended drainage group and in 8 of 30 patients in the resection group. The remaining patients had pain several times (*i.e.*, at least three attacks) per month.

All patients recruited for this study had been admitted to the hospital because of acute attacks of chronic pancreatitis. The median hospital stay was 26 days (range 12 to 123) in the extended drainage group and 21 days (range 10 to 102) in the resection group. This did not include the period immediately before surgery that was used for workup.

In addition, patients completed the European Organisation for Research and Treatment of Cancer's quality-of-life questionnaire.[21] It comprises single and multitrait scales on symptoms, physical status, working ability, and emotional, cognitive, and social functioning, as well as a global qual-

Table 2. EXOCRINE PANCREATIC FUNCTION TESTS

	Extended Drainage Group (n = 31)		Resection Group (n = 30)	
	Preoperative (%)	Follow-up (%)	Preoperative (%)	Follow-up (%)
Fecal chymotrypsin test				
Normal*	45	42	40	17
Pathologic*	55	58	60	83
Pancreolauryl test				
Normal*	13	10	10	0
Intermediate*	32	22	30	17
Pathologic*	55	58	60	83

* Definition see Patients and Methods.

Table 3. ENDOCRINE PANCREATIC FUNCTION TESTS

Test	Extended Drainage Group (n = 31)		Resection Group (n = 30)	
	Preoperative (%)	Follow-up (%)	Preoperative (%)	Follow-up (%)
Serum-Insulin				
Normal*	68	68	67	60
Pathologic*	32	32	33	40
Serum-C-peptide				
Normal*	68	68	67	60
Pathologic*	32	32	33	40
HbA_{1c}				
Normal*	71	71	73	63
Pathologic*	29	29	27	37
OGTT				
Normal*	32	26	33	23
Impaired*	39	45	40	40
Pathologic*	29	29	27	37

* Definition see Patients and Methods.
OGTT = oral glucose tolerance test.

ity-of-life scale (Tables 5 and 6). This quality-of-life questionnaire had previously been validated for patients with chronic pancreatitis.[20]

Quality-of-life and pain score data were recorded by doctoral students who were unaware of group allocation.

Surgical Procedure

The extended drainage procedure (LPJ-LPHE) was performed in 31 patients, and PPPD was performed in 30 patients using surgical techniques described elsewhere.[9,13] In the former, a choledochotomy was performed and a metal probe was inserted into the duodenum to allow better identification of the distal common bile duct in its retropancreatic course.[15] The common bile duct was drained with a T-tube for 10 days after surgery. T-tube cholangiography was performed routinely before removal of the tube. Histopathologic examination of the resected specimen confirmed chronic pancreatitis in all patients. All patients were reassessed in the outpatient clinic at 6-month intervals.

Randomization and Statistical Analysis

The primary endpoint of the study was improvement of quality of life. Further main outcome criteria were pain relief and definitive control of complications arising from adjacent organs. Secondary outcome criteria were mortality and morbidity rates and exocrine and endocrine pancreatic function after surgery, and occupational rehabilitation.[22]

In accordance with the guidelines proposed by McPeek et al.,[23] an educated guess based on literature review and personal experience was made setting the probability of improvement of global quality of life by >100% of the baseline value to 40% for the resection group and to 80%

Table 4. PAIN SCORE

Criterion	Extended Drainage Group (n = 31)			Resection Group (n = 30)		
	Preoperative Score (median [range])	Follow-up Score (median [range])		Preoperative Score (median [range])	Follow-up Score (median [range])	
Pain visual analog scale	81 (60–100)	12 (0–20)		82 (55–100)	10 (0–15)	
Frequency of pain attack	75 (50–100)	12.5 (0–25)		75 (50–100)	12.5 (0–15)	
Pain medication	17 (15–80)	0 (0–15)		20 (20–100)	0 (0–20)	
Inability to work*	75 (75–100)	0 (0–100)		75 (75–100)	50 (0–100)	
Pain score†	62 (50–100)	6.1 (0–40)	(p<0.001)‡	63 (50–100)	18.1 (0–37.5)	(p<0.001)‡

* Occupational rehabilitation was achieved in 21 of 31 (68%) and in 13 patients (43%) in the drainage and resection group, respectively.
† The pain score was defined as the sum of the rank values of the four criteria divided by four (see ref. no. 20).
‡ Preoperative values are compared with follow-up values (Wilcoxon rank test).

Table 5. QUALITY OF LIFE ASSESSMENT: FUNCTION SCALES

	Extended Drainage Group (n = 31)			Resection Group (n = 30)		
Functional Scales	Preoperative Score (median [range])	Follow-up Score (median [range])		Preoperative Score (median [range])	Follow-up Score (median [range])	
Physical status	60 (20–100)	90 (60–100)	(p<0.01)*	50 (0–100)	70 (20–100)	(p<0.05)*
Working ability†	50 (0–100)	100 (0–100)	(p<0.01)*	50 (0–100)	70 (0–100)	(p<0.05)*
Cognitive functioning	50 (40–80)	66.7 (50–100)	ns*	50 (40–80)	66.7 (40–100)	ns*
Emotional functioning	25 (0–75)	75 (50–100)	(p<0.01)*	25 (0–100)	66.7 (40–100)	(p<0.05)*
Social functioning	16.7 (0–66.7)	66.7 (50–100)	(p<0.01)*	16.7 (0–100)	66.7 (0–100)	(p<0.05)*
Global quality of life	28.6 (14.3–57.1)	85.7 (71.4–100)	(p<0.01)*	28.6 (14.3–71.4)	57.1 (33.3–100)	(p<0.05)*

* Preoperative values are compared with follow-up values (Wilcoxon Rank Test).
† Occupational rehabilitation was achieved in 21 of 31 (68%), and in 13 patients (43%) in the drainage and resection group, respectively.
These functional scales are part of an established quality of life questionnaire validated for patients with chronic pancreatitis (see ref. no. 20).

for the extended drainage group. On the premise of an α error of 5% and a β error of 15%, the size was set at 30 patients per group.[24]

Randomization was performed using a list of random digits[24] that were made available during surgery as coded cards sealed in envelopes.

The results of parametric data are expressed as means ± standard deviation. Nonparametric data are expressed as medians. Normal distribution of data was tested with the Kolmogorov–Smirnov test. Statistical significance was estimated using the Student's t test, the Wilcoxon rank test, the Mann–Whitney test, or the Fisher exact test, as appropriate. The level of significance was set at $p < 0.05$.

RESULTS

The mean surgical time was 245 ± 62 minutes in the extended drainage group and 328 ± 76 minutes in the resection group ($p < 0.05$). The mean number of transfused blood units was 1.2 ± 0.8 in the extended drainage group and 3.2 ± 2.6 in the resection group ($p < 0.05$). The overall morbidity rate was 19% in the extended drainage group and 53% in the resection group ($p < 0.05$). One patient in the extended drainage group died of cardiopulmonary failure after myocardial infarction (Table 7). All postsurgical complications were controlled conservatively.

During the median follow-up of 24 months (range 12 to

Table 6. QUALITY OF LIFE ASSESSMENT: SYMPTOM SCALES

	Extended Drainage Group (n = 31)			Resection Group (n = 30)		
Symptom Scales	Preoperative Score (median [range])	Follow-up Score (median [range])		Preoperative Score (median [range])	Follow-up Score (median [range])	
Fatigue	66.7 (33.3–100)	33.3 (0–50)	(p<0.05)*	66.7 (33.3–100)	33.3 (0–66.7)	(p<0.05)*
Nausea and vomiting	50 (0–100)	0 (0–50)	(p<0.05)*	50 (0–100)	0 (0–66.7)	(p<0.05)*
Pain	75.0 (50–100)	0 (0–25)	(p<0.01)*	75 (50–100)	0 (0–20)	(p<0.01)*
Loss of appetite	66.7 (0–100)	0 (0–16.7)	(p<0.01)*	75 (0–100)	0 (0–50)	(p<0.05)*
Dyspnea	0 (0–33.3)	0 (0–33.3)	ns*	0 (0–16.7)	0 (0–33.3)	ns*
Sleep disturbance	33.3 (0–66.7)	16.7 (0–66.7)	ns*	33.3 (0–66.7)	16.7 (0–66.7)	ns*
Constipation	33.3 (0–66.7)	33.3 (0–66.7)	ns*	33.3 (0–66.7)	33.3 (0–66.7)	ns*
Diarrhea	33.3 (0–66.7)	0 (0–33.3)	(p<0.05)*	33.3 (0–66.7)	0 (0–66.7)	(p<0.05)*
Financial strain	0 (0–33.3)	0 (0–33.3)	ns*	0 (0–33.3)	0 (0–33.3)	ns*
Loss of body weight	66.7 (66.7–100)	0 (0–33.3)	(p<0.01)*	66.7 (66.7–100)	16.7 (0–75)	(p<0.05)*
Fever	0 (0–16.7)	0 (0–0)	ns*	0 (0–16.7)	0 (0–0)	ns*
Jaundice	33.3 (0–66.7)	0 (0–16.7)	(p<0.05)*	33.3 (0–100)	0 (0–0)	(p<0.05)*
Bloating	33.3 (0–66.7)	0 (0–16.7)	ns*	33.3 (0–66.7)	16.7 (0–66.7)	ns*
Thirst	0 (0–33.3)	0 (0–33.3)	ns*	0 (0–33.3)	0 (0–33.3)	ns*
Pruritus	0 (0–33.3)	0 (0–33.3)	ns*	0 (0–33.3)	0 (0–33.3)	ns*
Treatment strain	71.4 (42.8–100)	14.3 (0–42.8)	(p<0.01)*	71.4 (28.6–100)	28.6 (0–57.1)	(p<0.05)*
Hope and confidence	28.6 (42.8–100)	85.7 (57.1–100)	(p<0.05)*	28.6 (14.3–71.4)	71.4 (42.9–100)	(p<0.05)*

* Preoperative values are compared with follow-up values (Wilcoxon Rank Test).
These symptom scales are part of an established quality of life questionnaire validated for patients with chronic pancreatitis (see ref. no. 20).

Table 7. POSTOPERATIVE COMPLICATIONS

Complication	Extended Drainage Group (n = 31)	Resection Group (n = 30)
Hemorrhage (> 3 units of blood postoperative)	1	2
Pancreatic fistula	1	2
Delayed gastric emptying*	0	9
Wound infection	3	3
Myocardial infarction and cardiopulmonary failure (fatal)	1	0
Total	6 (p<0.05)†	16

* Delayed gastric emptying was defined as need for gastric tubing for more than 7 days or return to solid diet after postoperative day (see ref. no. 36). The nasogastric tube was removed routinely, if the patient's reflux was < 200 ml/24 hours. This was the case in all patients of the drainage group on postoperative day two. Following the same criteria the nasogastric tube was removed on day 5 as a median (range 3 to 20 days) in the resection group. In the nine patients of the resection group, in which delayed gastric emptying was diagnosed, reflux was between 600 and 1400 ml per 24 hours after postoperative day 7.
† Fisher exact test.

36), relief of symptoms was observed in 28 of 31 patients (90%) in the extended drainage group and in 26 of 30 patients (87%) in the resection group (not significant). The median pain score decreased by 90% in the extended drainage group and by 71% in the resection group (see Table 4). Total relief of symptoms was experienced by all patients in both groups who had duodenal stenosis. Common bile duct stenosis was permanently controlled in 89% (16 of 18) of patients in the extended drainage group and in all patients (16 of 16) in the resection group. The remaining two patients (extended drainage group) required temporary endoscopic stenting because of cholestasis.

Before surgery, the body weight loss exceeded 10% of normal body weight (normal body weight [kg] = height [cm] − 100) in 17 patients in the extended drainage group (mean loss 8.2 ± 2.3 kg) and 18 patients in the resection group (mean loss 8.6 ± 2.9 kg). During follow-up, 25 of 31 patients (81%) in the extended drainage group and 12 of 30 patients (40%) in the resection group gained >5 kg. Median increase of body weight after surgery was 6.7 kg (range 3.1 to 9.2) in the extended drainage group and 1.9 kg (range 0 to 6.3) in the resection group.

Before surgery, exocrine pancreatic function, assessed by fecal chymotrypsin concentration and the pancreolauryl test, was normal or intermediate in 45% of the extended drainage group and 40% of the resection group and pathologic in 55% and 60%, respectively (see Table 2). Patients with pathologic exocrine function had received exocrine pancreatic enzyme substitution before surgery. During follow-up, one patient in the extended drainage group and seven patients in the resection group were found to have pathologic values. All patients with pathologic exocrine pancreatic function received a porcine pancreatic enzyme preparation (3 × 2 capsules daily, 1000 IU protease, 18,000 IU amylase, and 20,000 IU triacylglycerol-lipase per capsule).

Before surgery, nine patients in the extended drainage group and eight in the resection group had insulin-dependent diabetes. Before surgery, 24 patients (12 per group) had impaired glucose tolerance. Although three patients in the extended drainage group exhibited remarkable improvement of their diabetic status (saving 20, 20, and 24 IU of insulin per day), glucose tolerance deteriorated in three patients in the resection group after surgery, with an evolving need for insulin medication. The remaining patients with clinical diabetes mellitus remained stable. Five of the 20 patients with normal glucose metabolism before surgery (2 of 10 in the extended drainage group and 3 of 10 in the resection group) had impaired glucose tolerance after surgery (see Table 3).

Inability to work on a regular basis for at least 6 months was found in 84% of patients (26 of 31) in the extended drainage group and in 80% (24 of 30) in the resection group. Occupational rehabilitation—return to regular daily work or activity—was observed in 68% (21 of 31) of patients in the extended drainage group and in 43% (13 of 30) of patients in the resection group ($p < 0.05$).

During follow-up, seven patients admitted continued alcohol abuse according to the criteria of Lankisch et al.[1] In another eight patients who did not acknowledge alcohol consumption, strong suspicion of continued drinking was based on communication with referring physicians and close relatives.

During follow-up, median global quality of life improved by 200% in the extended drainage group and by 100% in the resection group ($p < 0.05$). Physical status and working ability scores improved by 67% and 50% in both groups. Physical status, working ability, and emotional, cognitive, and social functioning improved in both groups. Improvement of physical status and working ability were significantly better in patients who had undergone the extended drainage procedure (see Table 5). Results of the symptom scales are summarized in Table 6.

DISCUSSION

The indications for surgical intervention in chronic pancreatitis are intractable pain, complications related to adjacent organs, failure to control pancreatic pseudocysts by endoscopy in conjunction with ductal pathology, and intractable internal pancreatic fistula.[1,25,26] Occasionally, surgery is indicated if pancreatic cancer cannot be excluded despite a broad diagnostic workup.[27] The ideal surgical approach should address all these problems.

Pain is the crucial symptom in severe chronic pancreatitis. Based on the hypotheses of pain origin in chronic pancreatitis—perineural inflammation[4] and ductal hypertension[2]—drainage and resection have emerged as the two

Table 8. AIMS OF SURGICAL TREATMENT FOR CHRONIC PANCREATITIS

1. Pain relief
2. Control of pancreatitis associated complications of adjacent organs
3. Preservation of exocrine and endocrine pancreatic function
4. Social and occupational rehabilitation
5. Improvement of quality of life

main principles of surgery. However, procedures that involve either drainage or resection exclusively[25,26,28–31] have failed to meet all the aims of an ideal surgical treatment for chronic pancreatitis (Table 8).

More recently, various procedures have been either proposed[10,13] or rediscovered[8,9] that involve both drainage and resection, with emphasis on one or the other. Classic partial pancreatoduodenectomy (Whipple procedure), PPPD (Traverso–Longmire procedure), duodenum-preserving resection of the head of the pancreas (Beger procedure), and LPJ-LPHE (Frey procedure) provided pain relief, controlled complications arising from adjacent organs, and identified pancreatic cancer during surgery that had been missed despite a broad diagnostic workup.[6,7,27,32] Even with this kind of experience, the superiority of any of these procedures cannot be determined. To provide information about which procedure should be favored, prospective randomized trials are necessary that incorporate the criteria proposed by Frey et al.[22] for studies of therapeutic interventions in chronic pancreatitis: pain intensity, analgesic use, exocrine and endocrine pancreatic function, professional rehabilitation, and quality of life.

In 1995, prospective randomized studies were reported by Klempa et al.[12] comparing partial pancreatoduodenectomy (Whipple procedure) with duodenum-preserving resection of the head of the pancreas (Beger procedure),[12] by Buechler et al.[11] comparing PPPD (Traverso–Longmire procedure) with duodenum-preserving resection of the head of the pancreas, and by our group[15] comparing LPJ-LPHE (Frey procedure) with duodenum-preserving resection of the head of the pancreas. Klempa et al. concluded that the Beger operation provided quicker recuperation and better preservation of exocrine and endocrine function and was equally effective in terms of pain relief. Buechler et al. preferred the Beger procedure to PPPD because of improved exocrine and endocrine function and higher efficacy in terms of pain relief. Except for a higher morbidity rate in the Beger procedure and failure of the Frey procedure to return nonocclusive segmental portal hypertension to normal, we found no significant difference between duodenum-preserving resection of the head of the pancreas and LPJ-LPHE.[33]

From these data, the gastroduodenal passage and common bile duct continuity-sparing techniques described by Beger and Frey may be considered favorable alternatives in surgery for severe chronic pancreatitis. The results of the present study support this conclusion. LPJ-LPHE provided equally effective pain relief and better preservation of pancreatic function. LPJ-LPHE also provided better quality of life and professional rehabilitation.

The question remains as to why these more or less resective procedures tend to provide better results with regard to permanent pain relief than simple drainage.[34] In a remarkable study reported by Warshaw et al.,[35] in 10 of 15 patients with "failure of symptomatic relief after pancreaticojejunal decompression," the pathologic key to recurrent pancreatitis was localized to the pancreatic head. Despite patent anastomoses, the progressive fibrotic inflammation in the pancreatic head had continued and thus acted as the pacemaker of the disease. In most patients who undergo surgical intervention, an inflammatory process in the head of the pancreas initiates at least one of the following problems: proximal stenosis of the duct of Wirsung or Santorini, distal common bile duct compression with recurrent clinical and subclinical episodes of cholangitis, segmental duodenal obstruction, and encasement of retropancreatic intestinal vessels (Fig. 1). In chronic pancreatitis, the crucial triangle lies between the distal common bile duct, the duct of Wirsung, and the superior mesenteric portal vein. This region is addressed by classic resection of partial pancreatoduodenectomy, PPPD, and duodenum-preserving subtotal pancreatic head resection. This triangle is also the target of the local pancreatic head excision step in the Frey procedure. The need for limited or more extensive local excision of critical pancreatic head fibrosis may be tailored to the individual situation (Fig. 2). It could be hypothesized that lateral drainage by longitudinal pancreaticojejunostomy is unnecessary, at least in patients who do not have a "chain of lakes," provided that the pacemaker, the pancreatic head, is cored out. However,

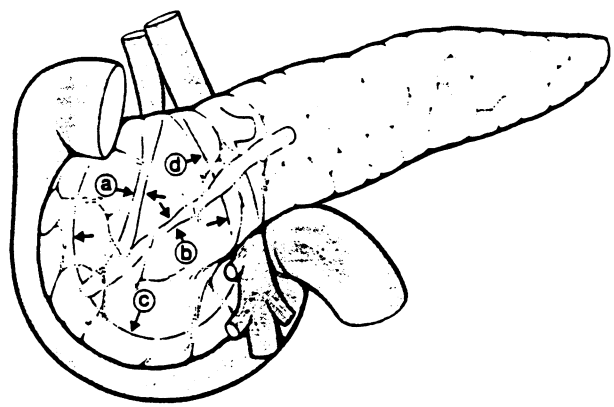

Figure 1. Complications attributed to the inflammatory process in the head of the pancreas, the pacemaker in chronic pancreatitis: (A) distal common bile duct compression, (B) proximal stenosis of the duct of Wirsung, (C) segmental duodenal obstruction, and (D) encasement of retropancreatic intestinal vessels. (From MW Buechler, Baer HU, Seiler C, et al. Die duodenumerhaltende Pankreaskopfresektion: ein Standardverfahren bei chronischer Pankreatitis. Chirurgerie 1997; 68:364–368, with permission from Springer-Verlag, Heidelberg, Germany.)

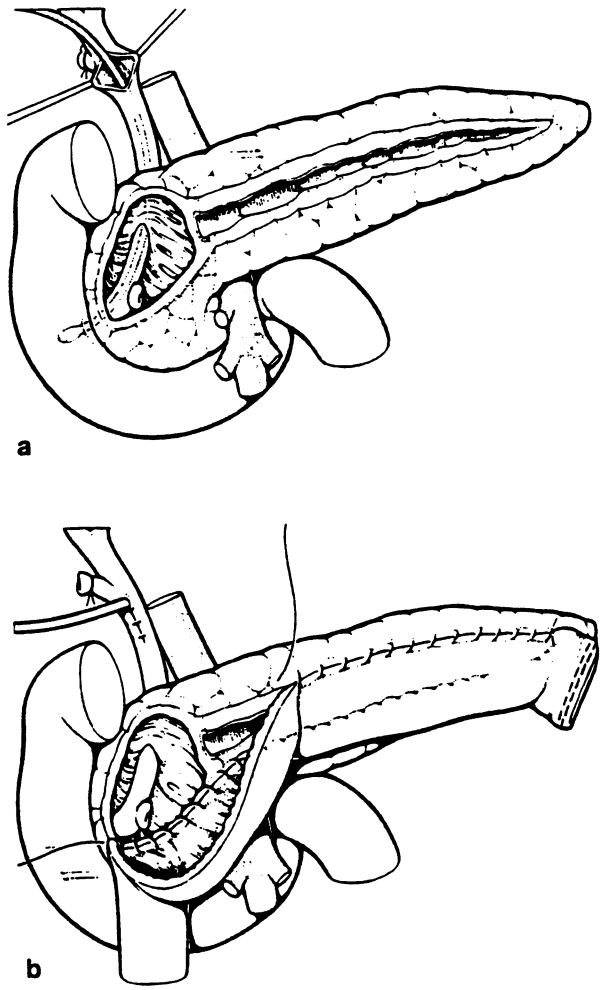

Figure 2. The extended drainage procedure described by Frey (longitudinal pancreaticojejunostomy combined with local pancreatic head excision). Through a proximal choledochotomy, a metal probe is inserted into the duodenum. (A) The triangle between the distal common bile duct, the duct of Wirsung, and the superior mesenteric portal vein is addressed during local pancreatic head excision. (B) Reconstruction with a longitudinal side-to-side pancreaticojejunostomy, including the cavity in the pancreatic head. (From Izbicki JR, Bloechle C. Die Drainageoperation als Therapieprinzip der chirurgischen organerhaltenden Behandlung der chronischen Pankreatitis. Chirurgerie 1997; 68:865–873, with permission from Springer-Verlag, Heidelberg, Germany.)

this question needs to be investigated in a prospective randomized trial.

It seems that the limited local pancreatic head excision is crucial in the critical triangle between the portal vein, main pancreatic duct, and distal common bile duct. A more extensive removal of pancreatic tissue in the pancreatic head and in the uncinate process may therefore be unnecessary.

On the premise that long-term results confirm the convincing results achieved with LPJ-LPHE (Frey procedure), this extended drainage procedure offers the advantages of drainage (*i.e.*, preservation of pancreatic function and limited surgical trauma) without the burdens of radical resection (*i.e.*, significant surgical and long-term morbidity rates). At the same time, the critical pancreatic head region, which acts as the pacemaker in chronic pancreatitis, is adequately addressed, providing pain relief and control of pancreatitis-associated complications from adjacent organs.

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References

1. Lankisch PG, Happe-Loehr A, Otto J, Creutzfeldt W. Natural course in chronic pancreatitis. Digestion 1993; 54:148–155.
2. Ebbehoj N, Svendsen LB, Madsen P. Pancreatic tissue pressure in chronic obstructive pancreatitis. Scand J Gastroenterol 1984; 19: 1066–1068.
3. Keith RG, Keshavjee SH, Kerenyi NR. Neuropathology of chronic pancreatitis in humans. Can J Surg 1985; 28:207–211.
4. Bockmann DE, Buechler M, Malfertheimer P, Beger HG. Analysis of nerves in chronic pancreatitis. Gastroenterology 1988; 94:1459–1469.
5. Karanjia ND, Widdison AL, Leung F, Alvarez C, Lutrin FJ, Reber HA. Compartment syndrome in experimental chronic obstructive pancreatitis: effect of decompressing the main pancreatic duct. Br J Surg 1994; 81:259–264.
6. 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; 220:492–507.
7. Buechler MW, Friess H, Bittner R, et al. Duodenum-preserving pancreatic head resection: long-term results. J Gastrointest Surg 1997; 1:13–19.
8. Whipple AO. Radical surgery for certain cases of pancreatic fibrosis associated with calcereous deposits. Ann Surg 1946; 124:991–1006.
9. Traverso LW, Longmire WP. Preservation of the pylorus in pancreaticoduodenectomy. Surg Gynecol Obstet 1978; 146:959–962.
10. Beger HG, Krautzberger W, Bittner R, Buechler M, Limmer J. Duodenum-preserving resection of the head of the pancreas in patients with severe chronic pancreatitis. Sugery 1985; 97:467–473.
11. Buechler M, Friess H, Mueller MW, Wheatley AM, Beger HG. Randomized trial of duodenum-preserving pancreatic head resection vs. pylorus-preserving Whipple in chronic pancreatitis. Am J Surg 1995; 169:65–70.
12. Klempa I, Spatny M, Menzel J, et al. Pankreasfunktion und Lebensqualitat nach Pankreaskopfresektion bei der chronischen Pankreatitis. Chirurgerie 1995; 66:350–359.
13. Frey CF, Smith GJ. Description and rationale of a new operation for chronic pancreatitis. Pancreas 1987; 2:701–707.
14. Partington PF, Rochelle RE. Modified Puestow procedure for retrograde drainage of the pancreatic duct. Ann Surg 1960; 152:1037–1042.
15. Izbicki JR, Bloechle C, Knoefel WT, Kuechler T, Binmoeller KF, Broelsch CE. Duodenum-preserving resections of the head of the pancreas in chronic pancreatitis: a prospective randomized trial. Ann Surg 1995; 221:350–358.
16. Axon AT, Classen M, Cotton PB, Cremer M, Freeny PC, Lees WR. Pancreatography in chronic pancreatitis: international definitions. Gut 1984; 25:1107–1112.
17. Ammann RW, Akovbiantz A, Largiader F, Schueler G. Course and outcome of chronic pancreatitis. Gastroenterology 1984; 86:820–828.
18. Barry RE, Barry R, Ene MD, Parker G. Fluorescein dilaurate: tubeless test for pancreatic exocrine failure. Lancet 1982; ii:742–744.
19. Albert KG, Kockaday TA. Diabetes mellitus. In Weatherall DJ, Ledingham JG, Warrell DA, eds. Oxford textbook of medicine. New York: Oxford Medical Publications, 1987; 9.51–9.101.

20. Bloechle C, Izbicki JR, Knoefel WT, Kuechler T, Broelsch CE. Quality of life in chronic pancreatitis: results after duodenum-preserving resection of the head of the pancreas. Pancreas 1995; 11:77–85.
21. Aaronson NK, Ahmedzai S, Berman B, et al. The European Organisation for Research and Treatment of Cancer QLQ-C30: a quality-of-life instrument for use in international clinical trials in oncology. J Natl Cancer Inst 1993; 85:365–376.
22. Frey CF, Pitt HA, Prinz RA. A plea for uniform reporting of patient outcome in chronic pancreatitis. Arch Surg 1996; 131:233–234.
23. McPeek B, Mosteller F, McKneally MF, Neugebauer EA. Experimental methods: clinical trials. In Troidl H, Spitzer WO, McPeek B, et al., eds. Principles and practice of research. New York: Springer, 1991: 114–125.
24. Fleiss JL. Statistical methods for rates and proportions. New York: John Wiley & Sons, 1981:33–49.
25. Frey CF, Suzuki M, Isaji S. Treatment of chronic pancreatitis complicated by obstruction of the common bile duct or duodenum. World J Surg 1990; 14:59–69.
26. Warshaw AL. Pain in chronic pancreatitis: patients, patience, and the impatient surgeon. Gastroenterology 1984; 86:987–989.
27. Saeger JD, Schwall G, Trede M. Standard Whipple in chronic pancreatitis. In Beger HG, Buechler M, Malfertheimer P, eds. Standards in pancreatic surgery. Berlin: Springer, 1993:385–391.
28. Greenlee HB, Prinz RA, Aranha GV. Long-term results of side-to-side pancreaticojejunostomy. World J Surg 1990; 14:70–76.
29. Frey CF, Child CG, Fry W. Pancreatectomy for chronic pancreatitis. Ann Surg 1976; 184:403–413.
30. Braasch JW, Vito L, Nugent FW. Total pancreatectomy for end-stage chronic pancreatitis. Ann Surg 1978; 188:317–323.
31. Dresler CM, Fortner JG, McDermott K, Bajorunas DR. Metabolic consequences of (regional) total pancreatectomy. Ann Surg 1991; 214:131–140.
32. Stapleton GN, Williamson RCN. Proximal pancreatoduodenectomy for chronic pancreatitis. Br J Surg 1996; 83:1433–1440.
33. Bloechle C, Busch C, Tesch C, et al. Prospective randomized study of drainage and resection on nonocclusive segmental portal hypertension in chronic pancreatitis. Br J Surg 1997; 84:477–482.
34. Adams DB, Ford MC, Anderson MC. Outcome after lateral pancreaticojejunostomy for chronic pancreatitis. Ann Surg 1994; 219:481–489.
35. Markowitz JS, Rattner DW, Warshaw AL. Failure of symptomatic relief after pancreaticojejunal decompression for chronic pancreatitis. Arch Surg 1994; 129:374–380.
36. Warshaw AL, Torchiana DL. Delayed gastric emptying after pylorus-preserving pancreaticoduodenectomy. Surg Gynecol Obstet 1985; 160: 1–4.