

# Roux-en-Y Drainage of the Pancreatic Stump Decreases Pancreatic Fistula After Distal Pancreatic Resection

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**Abstract** Clinically relevant fistula after distal pancreatic resection occurs in 5–30% of patients, prolonging recovery and considerably increasing in-hospital stay and costs. We tested whether routine drainage of the pancreatic stump into a Roux-en-Y limb after distal pancreatic resection decreased the incidence of fistula. From October 2001, data of all patients undergoing pancreatic distal resection were entered in a prospective database. From June 2003 after resection, the main pancreatic duct and the pancreatic stump were oversewn, and in addition, anastomosed into a jejunal Roux-en-Y limb by a single-layer suture ( $n=23$ ). A drain was placed near the anastomosis, and all patients received octreotide for 5–7 days postoperatively. The volume of the drained fluid was registered daily, and concentration of amylase was measured and recorded every other day. Patient demographics, hospital stay, pancreatic fistula incidence ( $\geq 30$  ml amylase-rich fluid/day on/after postoperative day 10), perioperative morbidity, and follow-up after discharge were compared with our initial series of patients (treated October 2001–May 2003) who underwent oversewing only ( $n=20$ ). Indications, patient demographics, blood loss, and tolerance of an oral diet were similar. There were four (20%) pancreatic fistulas in the “oversewn” group and none in the anastomosis group ( $p<0.05$ ). Nonsurgical morbidity, in-hospital stay, and follow-up were comparable in both groups.

**Keywords** Distal pancreatic resection · Pancreatic fistula · Roux-en-Y anastomosis · Morbidity

## Introduction

Pancreatic distal resection is a standardized procedure for the resection of lesions localized to the left of the portal vein. Despite advances in surgery during the last two decades, leakage from the pancreatic remnant after distal pancreatectomy presents a persistent problem.<sup>1,2</sup> Thus, the incidence of postoperative pancreatic fistulas varies between 5 and 30% in recent studies.<sup>3–10</sup> Various techniques

are used for closure of the pancreatic remnant, such as ligation of the pancreatic duct followed by closure of the pancreatic stump with or without a serosa patch or closure using a stapling device.<sup>6,11–14</sup> Interestingly, even when an identical technique was used, the reported incidence of fistulas varies widely.<sup>15</sup> This variation may be attributable to differences in the definition of “pancreatic fistula” but also to technical variabilities within groups of “identical” stump closure and to the heterogeneity of patient populations.<sup>16</sup>

Importantly, a recent study found that complications derived from pancreatic fistulas after distal pancreatectomy doubled the cost and dramatically increased health-care resource use.<sup>2</sup> Therefore, strategies are urgently needed that aid in reduction of the incidence of postoperative pancreatic fistulas, and thus, may decrease direct treatment costs. A retrospective survey found that draining the pancreatic remnant into an excluded loop of jejunum was only used sporadically.<sup>17,18</sup> We therefore tested the hypothesis that routine drainage of the pancreatic stump into a Roux-en-Y limb may decrease the fistula rate after pancreatic distal resection.

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Wagner and Gloor both contributed equally in this work.

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## Patients and Methods

From October 2001, all patients undergoing pancreatic surgery were enrolled in a prospective data registry. Patients underwent a standardized preoperative evaluation consisting of contrast-enhanced abdominal computed tomography or magnetic resonance imaging. In selected patients, endoscopic retrograde cholangio- and pancreatography was performed. In patients in whom cancer was suspected, resection was performed in the absence of hematogenous metastases and when no gross retroperitoneal neoplastic or complex vascular infiltration was evident. Surgery consisted of an en-bloc pancreatic left resection, together with the spleen and the adjacent lymphatic tissue in all these patients. The extension of the cancer into the body of the pancreas determined the amount of tissue that was resected. In patients with chronic pancreatitis, the indications for surgery were intractable pain, alteration of the left-sided pancreas (e.g., pseudocysts), duct stenosis, pancreatic stones, or suspicion of cancer. In these patients, the spleen was conserved whenever technically feasible.

From October 2001 to May 2003, stump closure for pancreatic distal resection was accomplished by closing the pancreatic duct with interrupted prolene sutures followed by oversewing the pancreatic stump, cut in a fish-tail-like fashion, with a second layer of interrupted sutures using a resorbable, atraumatic suture material (PDS, Ethicon, Switzerland).

From June 2003, a modification was applied consisting of suturing the pancreatic stump as described above followed by an end-to-side pancreatico-jejunostomy into a retrocolic Roux-en-Y limb with a length of at least 30 cm. The jejunum was opened slightly smaller than the diameter of the pancreas, and the anastomosis was performed in a capsule-to-mucosa fashion using a single layer resorbable, monofilament suture with interrupted stitches (PDS, Ethicon, Switzerland). A drain was placed near the anastomosis in all patients, and octreotide was administered for 5–7 days postoperatively ( $3 \times 0.2$  mg s.c. daily). All patients received, perioperatively, a single-dose antibiotic prophylaxis (amoxicillin and clavulanic acid, GlaxoSmithKline, Switzerland). Empiric antibiotic treatment was continued after surgery in patients with manifest infections until resistance probes were received or the clinical presentation ameliorated.

Postoperatively, patients were cared for in the intensive or intermediate care unit as needed. Fluid was given intravenously, and patients were allowed to drink fluids depending on the operative procedure and clinical presentation. Solid foods were administered according to gastrointestinal (GI) function using a stepwise dietary regimen. Abdominal drainage volume was registered daily, and the amylase concentration of drained fluid was measured and recorded every other day. Patient demo-

graphics, duration of hospital stay, incidence of pancreatic fistula, perioperative morbidity, and follow-up after discharge were recorded and compared with our previous series of patients in whom the pancreatic remnant was oversewn only. A pancreatic fistula was defined as secretion of at least 30 ml of amylase-rich fluid (more than 5,000 U/l) per day on or after the tenth postoperative day. Mortality was defined as the total in-hospital death rate. A biliary fistula was diagnosed if bilirubin-rich fluid was drained for more than 5 days. Bleeding was defined as the need for more than two units of packed red blood cells more than 24 h after operation or the need for reoperation for bleeding.

All variables were analyzed using the Fisher's exact test,  $\chi^2$  test, and Mann-Whitney  $U$  test, where appropriate, using SPSS Statistical Software (Chicago, IL, USA). All quantitative data are reported as median values and ranges. Differences at  $P < 0.05$  were considered statistically significant.

After discharge, all patients were seen in our outpatient clinic at least once. Thereafter, follow-up was registered using a standardized questionnaire, and patients were contacted by phone.

## Results

A total of 44 pancreatic distal resections were performed during the study period. One patient who underwent emergency pancreatic distal resection because of a rupture of the pancreas after blunt abdominal trauma was excluded from the analysis. The remaining 43 patients were included. A total of 23 patients underwent distal resection with a pancreatico-jejunostomy, and 20 patients underwent stump closure by simple suturing of the pancreatic remnant. Demographic characteristics are summarized in Table 1 and were comparable between the two groups. The histologic classification and the range of surgical treatments are shown in Table 2. A neoplasm was found in 74 and 85% of patients, respectively (group "anastomosis" vs "oversewn"). Mean operative time was 345 min after pancreatico-jejunostomy vs 305 min after "oversewing" only;  $p = 0.329$ . Duration until solid food intake was tolerated and duration of hospital stay (group 1: 13 days vs group 2: 16 days;  $p = 0.325$ ) was comparable between groups. Drains were removed after a mean duration of 6 days in both groups ( $p = 0.5$ ).

Postoperative morbidity is listed in Table 3. After pancreatico-jejunostomy, one patient had to be reoperated because of intra-abdominal bleeding in the region of the gastro-duodenal artery. Subsequently, this patient developed an intra-abdominal abscess caused by a localized necrosis in the pancreatic head and was treated by percutaneous drainage (amylase concentration of the drain fluid  $< 220$  U/l).

**Table 1** Demographics in Patients Undergoing Pancreatic Distal Resection ( $n=43$ )

Clinical Data	Group 1 ( $n=23$ ) (with Pancreaticojejunostomy)	Group 2 ( $n=20$ ) (No Anastomosis)	<i>P</i> Value
Age (years)	58 (22–78)	60 (18–84)	0.372
Gender:			
Male	9 (39%)	8 (40%)	0.954
Female	14 (61%)	12 (60%)	
ASA risk classification			
I–II	14 (67%)	14 (74%)	0.736
III–IV	7 (33%)	5 (26%)	
Body weight (%) <sup>a</sup>	97 (80–100)	97 (87–100)	0.417
Duration of symptoms (wk)	44 (1–468)	14 (1–200)	0.037
Diabetes mellitus	2	4 (20%)	0.398
Cardiac disease	7 (30%)	5 (25%)	0.708
COPD	2	1	0.999
Albumin <30 g/l	2	1	0.995
Creatinine >150 mmol/l	5 (22%)	2 (10%)	0.412

Quantitative variables are given as median (range). A Fisher's exact test or a  $\chi^2$  test was used for qualitative variables and a Mann–Whitney *U* test for quantitative variables.

ASA American Society of Anesthesiology, COPD chronic obstructive pulmonary disease

<sup>a</sup>Body weight as a percentage of pre-morbid body weight

One patient underwent interventional drainage for a retroperitoneal abscess after distal pancreatectomy with a pancreatico-jejunostomy and left nephrectomy. The amylase concentration in the drain fluid measured less than 500 U/l. No pancreatic fistula required an operative intervention; however, all four patients underwent interventional drainage. A 78-year-old female patient died from postoperative sepsis and multi-organ failure caused by an infected central venous line. The autopsy report revealed a vital and completely healed pancreatic

anastomosis and no signs suggesting an intra-abdominal cause of sepsis.

Follow-up was completed in 41 patients (95%). Two patients were lost to emigration. Median follow-up was 20 months (range 1–49), and mean survival was 33 months (95% C.I. 29–43). No readmission occurred as a result of a postoperative pancreatic fistula. Follow-up morbidity was comparable between the two groups. A total of 9 patients (29%) died because of recurrent malignant disease. Six patients were reoperated during follow-up: one patient underwent hepatic resection because of a recurrence of a neuroendocrine neoplasm; one patient required colon resection because of diverticulitis; and another patient underwent incisional hernia repair. The other three patients had extra-abdominal surgery. No patient required recurrent pancreatic surgery, and no patient who underwent pancreatico-jejunostomy developed bowel obstruction. Fourteen patients (32%) required insulin after pancreatic resection, and the incidence of pancreatogenic diabetes did not differ between the two groups. Enzyme supplementation was prescribed in 22 patients (51%), and six patients (14%) noted clinical signs of exocrine pancreatic insufficiency despite enzyme supplementation. The majority of patients could work or pursue their daily activities (75 and 66%, respectively, for groups “anastomosis” and “oversewn”).

**Table 2** Histology and Additional Surgical Procedures Performed in 43 Patients Undergoing Pancreatic Distal Resection

Operative Procedure	Group 1 ( $n=23$ ) (with Pancreaticojejunostomy)	Group 2 ( $n=20$ ) (No Anastomosis)
Histology		
Pancreatic neoplasms	13 (57%)	14 (70%)
Other neoplasms	4 (17%)	3 (15%)
Chronic pancreatitis	5 (22%)	2 (10%)
Other	1	1
Procedures		
Splenectomy	18 (78%)	18 (90%)
Liver resection	3 (13%)	3 (15%)
Gastric resection	3 (13%)	2 (10%)
Colon resection	3 (13%)	2 (10%)
Nephrectomy	3 (13%)	1
Adrenalectomy	2	2 (10%)
Necrosectomy	1	0

## Discussion

A pancreatic fistula according to a recently published classification is any measurable drainage on or after postoperative day 3 with an amylase content of more than

**Table 3** Postoperative Outcome (Frequency)

Parameters	Group 1 ( <i>n</i> =23) (with Pancreaticojejunostomy)	Group 2 ( <i>n</i> =20) (No Anastomosis)	<i>P</i> Value
Surgical morbidity			
Pancreatic fistula	0	4 (20%)	0.039
Bleeding	1	1	0.995
Intra-abdominal abscess	2 <sup>a</sup>	1 <sup>b</sup>	0.995
Biliary fistula	0	1 <sup>c</sup>	0.465
Relaparotomy	1	0	0.995
Nonsurgical morbidity <sup>d</sup>			
Cardiopulmonary	6 (26%)	3 (15%)	0.087
Renal	1	2 (10%)	0.590
Other	4 (13%)	2 (10%)	0.561
Mortality	1	0	0.995

A Fisher's exact test or a  $\chi^2$  test was used for qualitative variables and a Mann–Whitney *U* test for quantitative variables.

<sup>a</sup>Including the one patient requiring reoperation for bleeding in this group

<sup>b</sup>This patient also suffered from a pancreatic fistula

<sup>c</sup>Related to a liver resection that was performed together with the pancreatic left resection

<sup>d</sup>Systemic complications: cardiopulmonary, renal, sepsis, neural, others

three times the upper limit of serum amylase<sup>19</sup>. Three categories were defined: biochemical fistula without clinical sequelae (grade A); fistula requiring any therapeutic intervention (grade B); and fistula with severe clinical sequelae (grade C). Because the current study was begun in October 2001 and data were prospectively entered into a database, we did not use the new classification published in 2005. Retrospectively, all fistulas diagnosed in this paper were either grade B or grade C. The definition used in this study is the same as that used in previous analyses of our patients<sup>20,21</sup> and is in accordance with other published series from high-volume centers<sup>3,22</sup>. Several different techniques were used for the treatment of the pancreatic stump after distal resection<sup>6,11–14,23</sup>. In a large single-center series of 235 pancreatic distal resections performed between 1994 and 1997, the incidence of postoperative pancreatic fistula was 5%<sup>6</sup>. Others have reported a fistula rate of almost 30%.<sup>10</sup> However, assessment of data from different centers is limited because of differences in fistula definition and patient heterogeneity, precluding unbiased comparison of outcomes. We therefore chose to perform a single-center study and compared results with our new technique with those from an earlier group of patients otherwise treated identically but without a pancreaticojejunal anastomosis.

Patient demographics were well comparable in our two groups of patients despite published data from other centers reporting changes in patient characteristics and indications for resection over time (increase in age and more resections for cystic lesions and fewer for chronic pancreatitis)<sup>24</sup>. In an earlier retrospective observational survey of 113 patients, 46 were treated with an additional pancreaticoenteric anastomosis, and no superiority of this technique was

found.<sup>17</sup> Adam et al. performed a pancreaticoenteric anastomosis in 27 of 41 patients undergoing distal pancreatic resection between 1994 and 2001. The anastomosis was associated with a leak-rate of 7% (2/27) compared to 29% (4/14) in the control group, but the difference did not reach the level of significance because of small sample size.<sup>18</sup> In a prospective trial, 69 patients were randomly assigned to five treatment groups: suturing of the pancreatic stump, suturing and applying fibrin glue, suturing plus mesh, pancreaticojejunosomy, and stapler closure of the stump. The overall fistula rate was 19%, ranging from 7 to 33%, without a statistical advantage of one technique over the other.<sup>25</sup>

Besides technical reasons, the incidence of postoperative pancreatic fistula may also be influenced by the use of synthetic somatostatin analogues (octreotide, lanreotide, or vapreotide) and the texture of the gland. Three randomized trials evaluated the use of prophylactic octreotide in patients undergoing pancreaticoduodenectomy and found no benefit for the use of octreotide, as did a meta-analysis in 2002.<sup>22,26–28</sup> On the other hand, four randomized, placebo-controlled, multicenter trials reported significant decreases in overall complication rates, and two of the four reported significantly lowered rates of pancreatic fistula in patients receiving prophylactic octreotide. Based on such data, our patients all received octreotide, which is also in accordance with a recent meta-analysis, demonstrating a reduction in the incidence of complications with the use of synthetic somatostatin analogs.<sup>29</sup>

Pancreatic texture and consistency were correlated with a risk of postoperative pancreatic fistula development.<sup>30</sup> Partial resection of a fibrotic pancreas is associated with lower leak rates (0 to 5%) compared to resection of a soft pancreas (20 to 25%), while the incidence of a postoper-

ative fistula in a pancreas with an intermediate consistency is 3 to 5%<sup>22</sup>.

Reoperation, septic complications with localized abscesses, and bleeding are other rare but important complications and indicators of surgical quality, having also a major impact on health-care resource consumption and economic outcome.<sup>2,31</sup> In our series, there were three abscesses. However, the amylase concentration reached the level required for a pancreatic fistula only in the abscess in the patient from group 2.

Because of different health-care systems, duration of hospital stay for a given intervention in Switzerland, in general, is greater than those reported in series from the US. Thus, in Switzerland, many complications are diagnosed during the initial hospital stay. Accordingly, there was no early readmission for either postoperative fistula or for abscess or bleeding. This outcome is in contrast to a recent paper from the US reporting on 56 patients with distal pancreatic resection of whom eight developed a pancreatic fistula grade B or C. Six of these eight patients were readmitted.<sup>32</sup>

The duration of hospital stay was similar in both groups in our study, suggesting that not only the presence or absence of a pancreatic fistula but also other factors, such as the cardiopulmonary or renal comorbidity that was evenly present in both groups, had a major impact on the duration of the hospital stay.

The additional operative effort of creating a Roux-en-Y limb and performing an anastomosis increased the duration of the operation only a short time, but did not reach statistical difference most likely because of the small number of patients studied.

## Conclusion

This study may serve as an effort to evaluate Roux-en-Y drainage of the pancreatic stump after distal pancreatic resection. Further prospective randomized studies are needed to finally define the role of this technique in routine pancreatic left resection. Based on our results, a randomized trial would need 113 patients in each treatment arm to meet a power of 90% with a 5% two-sided significance level, assuming that a pancreatico-jejunostomy would modify the incidence of postoperative fistula after pancreatic distal resection by 15%.

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