Surgery 171 (2022) 1658–1664

Contents lists available at ScienceDirect

Surgery

journal homepage: www.elsevier.com/locate/surg

Incidence and impact of postoperative pancreatic fistula after minimally invasive and open distal pancreatectomy

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ARTICLE INFO

Article history:
Accepted 11 November 2021
Available online 11 December 2021

ABSTRACT

Background: Previous studies reported a higher rate of postoperative pancreatic fistula after minimally invasive distal pancreatectomy compared to open distal pancreatectomy. It is unknown whether the clinical impact of postoperative pancreatic fistula after minimally invasive distal pancreatectomy is comparable with that after open distal pancreatectomy. We aimed to compare not only the incidence of postoperative pancreatic fistula, but more importantly, also its clinical impact.
Methods: This is a post hoc analysis of a multicenter randomized trial investigating a possible beneficial impact of a fibrin patch on the rate of clinically relevant postoperative pancreatic fistula (International Study Group for Pancreatic Surgery grade B/C) after distal pancreatectomy. Primary outcomes of the current analysis are the incidence and clinical impact of postoperative pancreatic fistula after both minimally invasive distal pancreatectomy and open distal pancreatectomy.
Results: From October 2010 to August 2017, 252 patients undergoing distal pancreatectomy were randomized, and data of 247 patients were available for analysis: 87 minimally invasive distal pancreatectomy and 160 open distal pancreatectomies. The postoperative pancreatic fistula rate after minimally invasive distal pancreatectomy was significantly higher than that after open distal pancreatectomy (28.7% vs 16.9%, $P = .029$). More patients were discharged with an abdominal surgical drain after minimally invasive distal pancreatectomy compared to open distal pancreatectomy (30/87, 34.5% vs 26/160, 16.5%, $P = .001$). In patients with postoperative pancreatic fistula, additional percutaneous catheter drainage procedures were performed less often (52% vs 84.6%, $P = .012$), with fewer drainage procedures (median [range], 2 [1–4] vs 2, [1–7], $P = .014$) after minimally invasive distal pancreatectomy.
Conclusion: In this post hoc analysis, the postoperative pancreatic fistula rate after minimally invasive distal pancreatectomy was higher than that after open distal pancreatectomy, whereas the clinical impact was less.

Introduction

Morbidity after distal pancreatectomy remains high, ranging from 29% to 47%.[1–3] Clinically relevant postoperative pancreatic fistulas (POPF)[4] occur frequently after distal pancreatectomy and are associated with prolonged intra-abdominal drainage, hemorrhage, readmissions, sepsis, and mortality.[4,5]

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https://doi.org/10.1016/j.surg.2021.11.009

Several risk factors[6–9] and preventive strategies[10–12] for POPF have been proposed. Nonrandomized studies found comparable POPF rates between the minimally invasive and open approach.[13–15] Recently, the first multicenter randomized trial, however, reported a yet unexplained higher rate of POPF grade B/C after Minimally invasive distal pancreatectomy (MIDP) compared to open distal pancreatectomy (ODP) (39% vs 23%).[16] The second randomized trial on MIDP versus ODP found a not significant difference in the rate of POPF (31% vs 38%, $P = .581$).[17]

The randomized multicenter Closure of Pancreatic Remnant (CPR) trial aimed to determine whether pancreatic stump closure with an extra fibrin patch would lower the risk of POPF.[18] The study found no significant difference in POPF rates between procedures with and without an extra fibrin patch (20% vs 24%, $P = .539$, respectively). Because POPF was the primary outcome and both MIDP and ODP were included, the data originating from this study allowed for a post hoc analysis on not only the incidence, but also the clinical impact of POPF after MIDP and ODP. In this article we report the findings of this post hoc analysis of the CPR trial.

Methods

This is a post hoc analysis of data from the multicenter CPR randomized controlled trial, which studied the added value of placement of a TachoSil fibrin patch on the pancreatic stump after closure in patients undergoing a distal pancreatectomy to prevent POPF grade B/C (hereafter: POPF) according to the International Study Group on Pancreatic Surgery (ISGPS) 2016 classification.[4] The CPR trial was registered at the Netherlands Trial Registry (NTR6048) and included patients from 7 Dutch centers. The initial CPR study was approved by the medical ethics review board (number MEC13-433) of Erasmus MC (Rotterdam, The Netherlands). The ethics review board of the Amsterdam UMC, location Academic Medical Center (Amsterdam, The Netherlands), waived the need for informed consent for the current post hoc analysis.

In both groups, the pancreas was transected using a stapler or surgical scalpel with suturing. In both groups, no other additional stump closure techniques were allowed. Technical specifications for transecting the pancreas (eg, type of cartridge) were not defined in the study protocol; surgeons had to use the same technique for transecting the pancreas in both arms of the trial (with/without fibrin patch). All patients received the same type of surgical drain; a large open drain without suction.

In the CPR trial, according to protocol, each patient was supposed to receive an intra-abdominal drain next to the pancreatic stump. On the third postoperative day, serum amylase and drain fluid amylase levels were measured. Drain removal was recommended according to the study protocol from the third postoperative day onward, or later if amylase levels were less than 3 times the institutions upper limit of normal serum level amylase, independent of its total production. Patients without measurement of drain amylase and without the requirement of prolonged or additional drainage were classified as no POPF.

Clinical impact was assessed by the rate of percutaneous drainages, the total number of drainage procedures, the cumulative days of drain in situ, and the number of days between surgery and final drain removal. Information on additional treatment strategies for POPF were collected, such as endoscopic retrograde cholangiopancreatography (ERCP) with pancreatic duct stent placement or POPF-related readmission or reoperation within 90 days.

Secondary endpoints were other postoperative complications (ie, delayed gastric emptying, or postpancreatectomy hemorrhage), mortality, or other quality indicators such as length of hospital stay and readmission within 30 days. Delayed gastric emptying and postpancreatectomy hemorrhage were scored as present or absent according to the ISGPS definition.[19,20]

Pancreatic duct size was measured on preoperative imaging (mostly computed tomography scans) at the pancreatic neck. This was done at the level of the confluence of the portospleno-mesenteric confluence, in the anterior-posterior plane, hence not necessarily perpendicular to the pancreatic surface.

Postoperative complications were scored using the Clavien-Dindo classification; a Clavien-Dindo ≥ 3 was considered a major complication.[21] Conversion was defined as by Montagnini et al as an unplanned or unintended change in approach (example: laparoscopic distal pancreatectomy converted to open) required for either urgent (eg, bleeding) or nonurgent reasons (eg, tumor infiltrating to other organs, difficult exposure). Additional organ resection was defined as any organ resection during the same operative procedure (eg, kidney, colon, stomach), except cholecystectomy.

Additional analyses were done for potential differences in surgical outcome between the laparoscopic and robotic distal pancreatectomy groups.

Patients and setting

Eligible patients for the CPR trial were at least 18 years old, with an indication for distal pancreatectomy for all tumors (benign, premalignant, or malignant), an expected survival exceeding 12 months, WHO Karnofsky score performance status >50%, American Society of Anesthesiologists (ASA) I–II, and written informed consent. Exclusion criteria included current immunosuppressive therapy, chemotherapy within 2 weeks before operation, severe psychiatric or neurologic disease, and drug and/or alcohol abuse. Baseline characteristics included sex, age at time of surgery, body mass index, ASA classification, previous surgical history, and previous medical history such as diabetes and hypertension. No stratification for randomization was applied. Patients were included from 7 centers in The Netherlands (Erasmus MC Rotterdam, Amsterdam UMC [locations Academic Medical Center and Vrije Universiteit Medical Center], Radboud UMC Nijmegen, Catharina Hospital Eindhoven, UMC Utrecht, and UMC Groningen).

Follow-up for surgical outcomes was 90 days or until death.

Data analysis

Analysis was performed using SPSS Statistics 26.0 (IBM, Inc, Chicago, IL). Patients were divided based on type of intervention received, MIDP (including both the laparoscopic and robotic approach) or ODP. Analysis was by intention to treat; however, a sensitivity analysis was performed in which all data from converted cases (from minimally invasive to open) were excluded. Analyses were done mostly in the group of patients with POPF. Data for continuous variables are expressed as median and IQR, or mean and SD when appropriate. Distributions of dichotomous data are presented in percentages. When comparing MIDP with ODP for continuous variables, the Student's t test was used to analyze normally distributed data and the Mann-Whitney U test for non–normally distributed data. For dichotomous variables, the χ^2 test was used. When comparing laparoscopic, robotic, and open for continuous variables, differences between groups were tested using 1-way analysis of variance (ANOVA) for normally distributed data, and using the Kruskal-Wallis test for non–normally distributed data. The variables for which a significant difference was found were subjected to multiple comparisons (Bonferroni method).

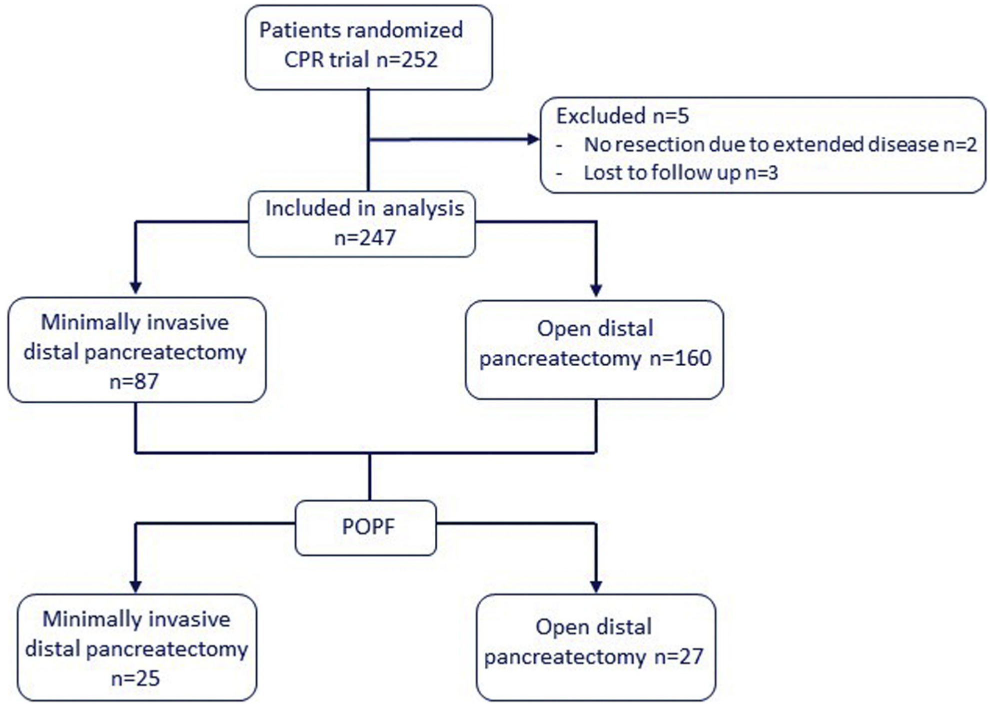

Figure 1. Flowchart of all included patients divided between type of approach.

Results

Between October 2010 and August 2017, a total of 252 patients were randomized to either MIDP or ODP. Two patients did not undergo a resection because metastatic disease was discovered before surgery, and 3 patients were lost to follow-up. Thus, 247 patients were included, of whom 87 after MIDP and 160 after ODP (Figure I). Baseline characteristics of the total cohort and of the separate groups are provided in Table I. There were no significant differences between the 2 groups in sex, age, body mass index, Karnofsky performance score, and types of tumor resected.

Perioperative outcomes

Perioperative outcomes are summarized in Table II. Stapler transection was more commonly used in the MIDP group (80.5% vs 67.5%, $P = .013$). The conversion rate of MIDP was 14.9% ($n = 13$). Nonurgent reasons for conversion were technical inability to proceed minimally invasively/adhesions ($n = 10$); urgent reasons were bleeding ($n = 3$).

Additional organ resection was more often performed during ODP (3.4% vs 8.8%, $P = .116$). Length of hospital stay was shorter after MIDP (6 vs 8 days, $P < .001$). More patients after MIDP were discharged with an abdominal drain in situ ($n = 30$, 34.5% vs $n = 26$, 16.5%, $P = .001$). The POPF rate was significantly higher after MIDP (28.7% vs 16.9%, $P = .029$).

Details on perioperative outcomes between laparoscopic, robotic, and open distal pancreatectomy are shown in Supplementary Table S2. Pairwise comparisons showed that the rate of POPF in laparoscopic DP was higher than that in ODP ($n = 21$, 31.3% vs $n = 27$, 16.9% $P = .045$).

A sensitivity analysis excluding converted patients ($n = 13$) is provided in Supplementary Table S3. There were no significant differences in outcomes between MIDP and ODP compared to the whole cohort.

Clinical impact of POPF

These are results of analyses including data patients with POPF only and are presented in Table III. Additional percutaneous catheter drainage was required in a lower proportion of patients after MIDP compared to patients after ODP ($n = 13$, 52.0% vs $n = 22$, 84.6%, $P = .012$). The total number of drainages was lower after MIDP (median [range] 2 [1–4] vs 2 [1–7], $P = .014$) compared to ODP. Length of stay was significantly shorter after MIDP (median 6 days vs 15 days, $P < .001$). Major complication rate was significantly lower after MIDP ($n = 17$, 68.0% vs $n = 24$, 92.3%, $P = .029$). The rate of readmission related to POPF was comparable between the groups (60.3% vs 59.3%, $P = .957$).

Nine patients (17.3%) underwent an ERCP with pancreatic duct stent placement: 3 (12.0%) after MIDP and 6 (22.2%) after ODP. Almost two-thirds (59.6%) of the patients with a POPF were readmitted, in all directly related to POPF, 15 after MIDP and 16 after ODP. Four out of 17 (23.5%) reoperations were POPF-related, 1 after MIDP and 3 after ODP. Other reoperations were necessitated by gastrointestinal perforation ($n = 7$), bleeding ($n = 3$), and a persistent ileus ($n = 1$). In 1 case, the drain broke at the level of the fascia and had to be removed under general anesthesia.

Drain management in POPF grade B

To be able to assess if the higher rate of POPF in the MIDP group was related to the early discharge with the surgical drain in situ, we collected detailed data on drain management in patients with POPF grade B (Figure 2). In MIDP, 13 out of 24 (54.2%) patients needed an additional drainage, and 1 patient underwent an ERCP with stent placement to treat POPF. The 10 other patients were all classified as POPF B due to prolonged drainage of more than 21 days. In 7 patients (29.2%), the drain was left in situ after the first outpatient visit due to high drain production, of which 3/7 also had a high drain amylase. In the other 4/7 patients after MIDP, drain amylase was not determined. For 3 patients (12.5%), the

Table I
Baseline characteristics of 247 patients undergoing minimally invasive or open distal pancreatectomy

	Total (*N* = 247)	MIDP (*N* = 87)	ODP (*N* = 160)	P value
Sex, male	109 (44.1)	45 (51.7)	64 (40.0)	.076
Age (years)*	60 (14)	59 (13)	60 (14)	.824
BMI*	25.8 (5.1)	25 (5.0)	26 (5.1)	.963
Karnofsky performance score*	88 (10)	89 (10)	87 (10)	.389
Comorbidities				
Hypertension	62 (25.1)	18 (20.7)	44 (27.5)	.238
Diabetes	37 (15.0)	13 (14.9)	24 (15.0)	.990
Indication operation				.571
PDAC	64 (25.9)	18 (20.7)	46 (28.7)	
Neuroendocrine tumor	60 (24.3)	22 (25.3)	38 (23.8)	
Other cystic lesions	36 (14.6)	10 (11.5)	26 (16.3)	
IPMN	30 (12.1)	13 (14.9)	17 (10.6)	
Chronic pancreatitis	22 (8.9)	9 (10.3)	13 (8.1)	
Pseudopapillary tumor	10 (4.0)	4 (4.6)	6 (3.8)	
Other	24 (9.7)	11 (12.6)	13 (8.1)	
Indication, PDAC	64 (25.9)	18 (20.7)	46 (28.7)	.159
Preoperative dilated pancreatic duct	63 (25.5)	20 (23.0)	43 (26.9)	.343
Missing	55 (22.3)	17 (19.5)	38 (23.8)	

Values in parentheses are percentages unless stated otherwise.
BMI, body mass index; *PD*, pancreatic duct; *IQR*, interquartile range; *IPMN*, intraductal papillary mucinous neoplasm; *MIDP*, minimally invasive distal pancreatectomy; *ODP*, open distal pancreatectomy; *PDAC*, pancreatic ductal adenocarcinoma.
* Mean (SD).

Table II
Perioperative outcomes

	Total (*N* = 247)	MIDP (*N* = 87)	ODP (*N* = 160)	P values
Distal pancreatectomy				.724
Including splenectomy	140 (56.7)	48 (55.2)	92 (57.5)	
Spleen preservation	107 (43.3)	39 (44.8)	68 (42.5)	
Drain placed intraoperatively	237 (96.7)	82 (94.3)	155 (98.1)	.105
Stump closure method				.013
Stapler	178 (71.5)	70 (80.5)	108 (67.5)	
Suture closure	61 (24.5)	13 (14.9)	47 (29.4)	
Missing	9 (4.0)	4 (4.6)	5 (3.1)	
TachoSil use	125 (50.6)	47 (54.0)	78 (48.8)	.429
Conversion to open	13 (14.9)	13 (14.9)	-	-
Additional organ resection	17 (6.9)	3 (3.4)	14 (8.8)	.116
Amylase drain fluid checked	217 (91.6)	77 (93.9)	140 (90.3)	.974
Amylase drain fluid checked but no result	18 (8.3)	4 (5.2)	14 (10.0)	.230
Amylase drain fluid raised on day 3	115 (57.8)	48 (65.8)	67 (53.2)	.083
Amylase unknown	48 (19.4)	14 (16.1)	34 (21.3)	.328
Intensive care unit stay	27 (10.9)	9 (10.3)	18 (11.3)	.851
Length of stay, days†	7 (6–10)	6 (4–7)	8 (7–11)	<.001
Blood loss, mL†	420 (200–1000)	200 (100–500)	630 (300–1500)	<.001
Clavien-Dindo grade ≥3	66 (26.7)	21 (24.1)	45 (28.1)	.503
Postpancreatic hemorrhage B/C	8 (3.2)	2 (2.3)	6 (3.8)	.548
Reoperation within 30 days	17 (6.9)	3 (3.4)	14 (8.8)	.116
Readmission within 30 days	48 (19.4)	19 (21.8)	29 (18.1)	.481
90-day mortality	9 (3.6)	2 (2.3)	7 (4.4)	.406
POPF related outcomes:				
POPF	52 (22.3)	25 (28.7)	27 (16.9)	.029
No fistula/biochemical leak	184 (74.5)	61 (70.1)	126 (80.0)	.035
Grade B	47 (19.0)	24 (27.6)	23 (14.4)	
Grade C	5 (2.0)	1 (1.1)	4 (2.5)	
Unknown	1 (0.4)	1 (5.0)	0 (0)	
Discharge home with drain in situ	56 (22.7)	30 (34.5)	26 (16.5)	.001
Need for additional drain placement	43 (17.3)	14 (16.5)	29 (18.5)	.698
Cumulative days drain in situ†	5 (3–17)	5 (3–22)	5 (3–11)	.720
Postoperative days after last drain removal†	5 (3–17)	5 (3–25)	5 (3–11)	.664
Reoperation due to POPF (within 90 days)	4 (1.6)	1 (1.1)	3 (1.9)	.662
Readmission due to POPF (within 90 days)	31 (12.6)	15 (17.2)	16 (10.0)	.101

Values in parentheses are percentages unless stated otherwise.
MIDP, minimally invasive distal pancreatectomy; *ODP*, open distal pancreatectomy; *POPF*, postoperative pancreatic fistula.
† Median (IQR).

first postoperative outpatient clinic appointment took place later than scheduled, and the drain could be removed on this occasion.

In ODP, 19 out of 23 (82.6%) patients needed an additional catheter drainage. Two underwent an ERCP with stent placement to treat POPF (8.7%); 1 patient had a length of stay of 40 days, and the

Table III
Outcomes in all 52 patients with POPF

	Total (*N* = 52)	MIDP (*N* = 25)	ODP (*N* = 27)	P values
Sex, male	30 (57.7)	17 (68.0)	13 (48.1)	.148
Age (years)*	60 (11)	60 (12)	61 (11)	.467
BMI*	26.4 (3.6)	26.0 (3.2)	26.8 (3.9)	.641
Karnofsky*	88 (10)	89 (10)	87 (9)	.793
Indication malignancy	30 (57.7)	11 (44.0)	19 (70.4)	.030
Indication PDAC	13 (25.0)	3 (12.0)	10 (37.0)	.035
Distal pancreatectomy				.812
Including splenectomy	30 (57.7)	14 (56.0)	16 (59.3)	
Spleen preservation	22 (42.3)	11 (44.0)	11 (40.7)	
Drain intraoperatively	51 (98.1)	24 (96.0)	27 (100.0)	.294
Stump closure method				.056
Stapler	41 (78.8)	22 (88.0)	19 (70.4)	
Stitching	10 (19.2)	2 (8.0)	8 (29.6)	
Missing	1 (1.9)	1 (4.0)	0 (0)	
TachoSil use	24 (46.2)	11 (44.0)	13 (48.1)	.764
Conversion	-	3 (12.0)	-	-
Additional organ resection	5 (9.6)	1 (4.0)	4 (14.8)	.186
Amylase drain fluid level (day 1–3)	3125 (871–10000)	3540 (1051–9151)	2722 (703–14147)	.910
Amylases raised on day 3	43 (82.7)	21 (84.0)	22 (81.5)	.637
Missing	4 (7.7)	1 (4.0)	3 (11.1)	
ICU stay	7 (13.5)	4 (16.0)	3 (11.1)	.565
Length of stay, days†	9 (6–18)	6 (5–8)	15 (10–29)	<.001
Clavien-Dindo grade ≥3	41 (80.4)	17 (68.0)	24 (92.3)	.029
Postpancreatic hemorrhage B/C	4 (7.7)	1 (4.0)	3 (11.1)	.336
Reoperation within 30 days	7 (13.5)	1 (4.0)	6 (22.2)	.054
Readmission within 30 days	31 (59.6)	15 (60.0)	16 (59.3)	.957
90-day mortality	2 (3.8)	0 (0)	2 (7.4)	.165
POPF-related outcomes				
Grade B	47 (90.4)	24 (96.0)	23 (85.2)	.186
Grade C	5 (9.6)	1 (4.0)	4 (14.8)	
Discharge home with drain	41 (78.8)	22 (88.0)	19 (73.1)	.180
Drain switched/replaced	35 (67.3)	13 (52.0)	22 (84.6)	.012
Cumulative days drain in situ†	43 (28–68)	43 (28–71)	38 (27–57)	.386
Postoperative days after last drain removal†	49 (31–85)	50 (30–89)	48 (34–69)	.630
Reoperation due to POPF	4 (7.7)	1 (4.0)	3 (11.1)	.317
Readmission due to POPF	31 (59.6)	15 (60.0)	16 (59.3)	.957
Number of drainages†	2 (1–3)	2 (1–2)	2 (2–3)	.014
Number of drainages, median (range)	2 (1–7)	2 (1–4)	2 (1–7)	.014
Postoperative ERCP + PD stent	9 (17.3)	3 (12.0)	6 (22.2)	.330
Number of days postoperatively†	37 (18–57)	37 (23)	40 (12–63)	.796

Values in parentheses are percentages unless stated otherwise.
BMI, body mass index; *ICU*, intensive care unit; *IQR*, interquartile range; *MIDP*, minimally invasive distal pancreatectomy; *ODP*, open distal pancreatectomy; *PD*, pancreatic duct; *PDAC*, pancreatic ductal adenocarcinoma; *POPF*, postoperative pancreatic fistula.
* Mean (SD).
† Median (IQR).

drain was removed on day 38. In 1 patient, the drain was left in situ based on high drain production; drain amylase was not measured.

Discussion

This post hoc analysis of a multicenter randomized trial demonstrated a considerably lower clinical impact of POPF after MIDP compared to ODP. This is illustrated by the lower number of patients needing additional catheter drainages and the lower total number of drainages after MIDP. The higher rate of POPF after MIDP that we found is in part explained by the higher number of patients discharged earlier with the surgical abdominal drain in situ.

The 2 published randomized trials on MIDP versus ODP reported different outcomes on POPF after MIDP, one a comparable POPF rate between MIDP and ODP and the other a higher rate of POPF after MIDP.[16,17] A higher rate of POPF after MIDP could be related to earlier discharge of patients with surgical drains in situ resulting in delayed drain removal during an outpatient visit. In the current study this could have been the case in 7 out of 24 MIDP patients (29.2%) with a POPF grade B compared to 1 out of 23 (4.4%) in ODP. Therefore, this could indeed be a possible explanation for the higher POPF rate in the MIDP group. Some retrospective studies have reported a higher POPF rate after MIDP compared to ODP,[22] whereas others reported a comparable rate.[13,23] A meta-analysis comparing MIDP and OPD in patients with pancreatic ductal adenocarcinoma concluded that the rate of POPF was comparable between MIDP and ODP.[24] None of these aforementioned studies provided details about the clinical impact of POPF. Still, a future practice of early outpatient clinic appointments postoperatively with amylase measurement in drain fluid could prevent delay in drain removal.

Clinical implications of POPF varied widely between patients. Some were discharged after 5 days with a drain in situ that after 22 days or longer was removed in the outpatient clinic, whereas others needed multiple drainages or an ERCP with stent placements for which they needed to be readmitted. By including the total number of drainages and number of consecutive days with a drain in the analyses, we aimed to assess the impact of these drains.

During the study period, nearly all patients received at least 1 intraoperative drain, as advised in the study protocol. Nowadays, the routine use of intra-abdominal drainage after distal pancreatectomy is being questioned. An evaluation of 1,158 patients undergoing distal pancreatectomy found a higher rate of POPF in the “drain group” compared to the “no drain group” (19.4% vs 6.9%,

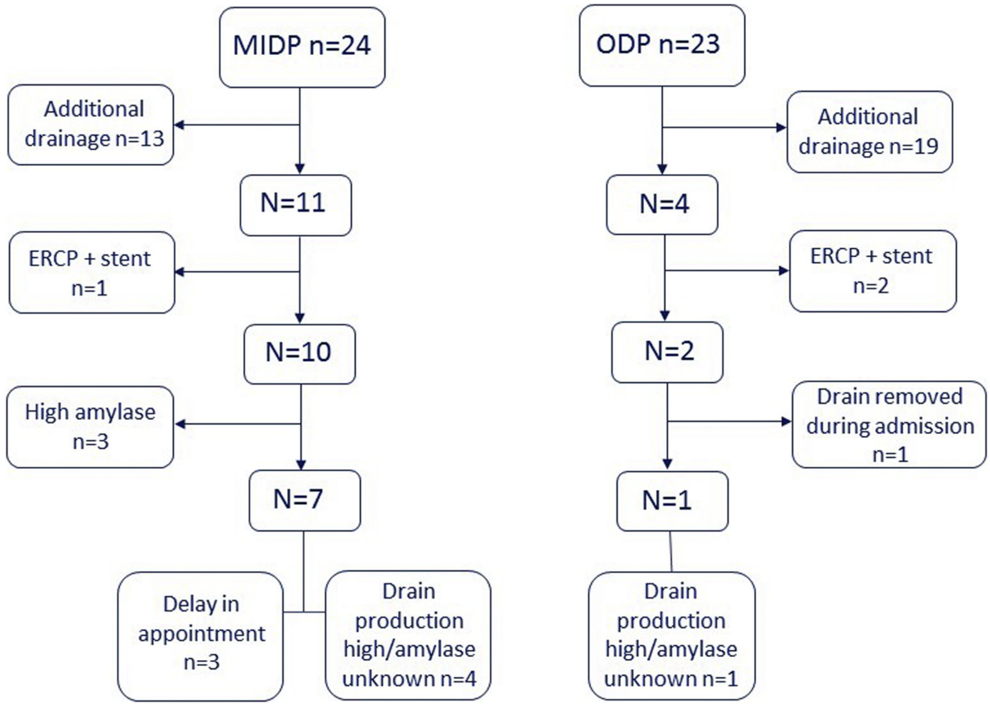

Figure 2. Flowchart of type of treatment in patients with a postoperative pancreatic fistula grade B divided between type of approach. MIDP, minimally invasive distal pancreatectomy; ODP, open distal pancreatectomy.

respectively; $P = .001$).[25] A multicenter randomized trial including 344 patients found no difference in clinically relevant POPF rates between patients undergoing distal pancreatectomy with or without a drain in situ. Percutaneous drain placement and reoperation and readmission rates did not differ between the 2 groups.[26] A second randomized trial assessing the use of intra-abdominal drains is underway.[27] A study on drain management in the 2014–2017 ACS-NSQIP database found that early drain removal (before postoperative day 3) was associated with lower odds of POPF compared to no drain placement (OR 0.33, 95% CI = 0.18–0.61).[28]

The ISGPS definition is currently the most used classification system for postoperative pancreatic fistula.[4] The definition of a grade B POPF includes prolonged drainage of 21 days. However, if no drain is placed intraoperatively, the definition of a grade B fistula does not hold, and it might need revision to the effect that drainage is (still) required 21 days postoperatively, regardless of number of days a drain was in situ.

In the CPR trial, the pancreatic stump was closed either using a stapler or sutures, both either with or without a TachoSil patch. The stapler was used more often in the minimally invasive group compared to the open group. Ad hoc logistic regression showed that method of stump closure was not a significant predictor of POPF ($P = .504$).[18] The drafters of a recently issued consensus guideline had assessed all the literature on the best management of the pancreatic transection plane and concluded that there is no superiority of one stump closure method over the other in terms of reducing the POPF rate.[29]

The findings of this study should be interpreted in light of some limitations. First, this is a post hoc analysis with limited numbers of POPF patients within a randomized study, making it difficult to draw robust conclusions. Confounding variables, including the closure technique (more suturing in ODP) and indications for surgery (fewer cancer cases in robotic operations), could be present. Therefore, studies with larger cohorts are needed to confirm these results. Second, the initial CPR trial had POPF as the primary outcome, and therefore included as well patients with extended disease with the need for additional resections (ie, colon or stomach). Additional organ resections were done more often in the ODP group, and this might have created bias when comparing outcomes such as length of hospital stay. Third, the MIDP procedures in this study were performed during the learning curve of MIDP in The Netherlands. After the nationwide LAELAPS training program had been implemented, the conversion rate gradually decreased from 38% to 8%. Still, the POPF rate did not improve much (28% vs 32%).[30] Fourth, some new variables were included in the current study, and since these data were collected in a retrospective fashion, this resulted in some missing data—for example, the amylase levels. Some data were not possible to retrieve at all, such as information on pancreatic texture and the exact location of the division line of the pancreas.

In conclusion, from this post hoc analysis, the POPF rate after MIDP was higher than that after ODP, whereas the total number and additional drainage procedures after MIPD was considerably less. Future prospective studies should confirm these results in larger cohorts and determine which patients will require adequate drainage, either during or after the operation.

Funding/Support

The initial Closure of the Pancreatic Remnant trial was supported by a grant from the Takeda Pharmaceutical Company. The current study received no additional funding.

Conflict of interest/Disclosure

Dr van der Heijde, Dr Lof, Prof. Busch, Dr de Hingh, Dr de Kleine, Prof. Molenaar, Dr Mungroop, Dr Stommel, Prof. Besselink, and Prof. van Eijck have no conflicts of interest or financial ties to disclose.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at [https://doi.org/10.1016/j.surg.2021.11.009].

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