A drainage strategy for postoperative pancreatic fistula after left-sided pancreatectomy based on the wall status of collected fluid

A running title: pancreatic fistula drainage

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Compliance with Ethical Standards

Enrollment into this study was performed with informed consents of the patients or their families. In addition, this study was performed in accordance with the Declaration of Helsinki.

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Abstract

Purpose Postoperative pancreatic fistula (POPF) after pancreatectomy is one of the severe postoperative adverse events. We aimed to clarify the outcomes of a strategy for POPF after left-sided pancreatectomy with one-step endoscopic ultrasonography-guided drainage (EUSD) and percutaneous drainage (PCD) based on the wall status of collected fluid.

Methods From January 2012 to September 2017, 90 of 336 patients developed grade B/C POPF and were retrospectively analyzed. Primary outcome measures were the technical and clinical success and resolution rates. Secondary outcome measures were time from surgery to intervention, and time from intervention to discharge/resolution or stent/tube removal and adverse events.

Results Seventeen patients underwent EUSD and 73 patients underwent PCD for POPF. The technical success rates were 100% in both the EUSD and PCD groups. The clinical success and resolution rates in the EUSD group were 100%, while those in the PCD group were 98.6%. The time from surgery to intervention was significantly longer in the EUSD group than in the PCD group (20 vs. 11 days, $p < 0.001$). The time from intervention to discharge/resolution was significantly shorter in the EUSD group than in the PCD group (11 vs. 22 days, $p < 0.001$/10 vs. 20 days, $p < 0.001$). The time from intervention to stent/tube removal was significantly shorter in the PCD group than in the EUSD group (20.5 vs. 873 days, $p < 0.001$). Adverse event rates were similar in the two groups (11.8% vs. 5.5%).

Conclusion A drainage strategy for POPF based on the wall status of collected fluid is appropriate.

Keywords: pancreatic fistula, endoscopic ultrasonography, percutaneous drainage, pancreatectomy, resection

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Introduction

Pancreatic fistula after pancreatic resection is one of the several possible severe postoperative adverse events (AEs) that lead to serious conditions such as hemorrhagic shock and abdominal abscess. The definition of postoperative pancreatic fistula (POPF) varied depending on the institution and country. Thus, a precise systematic review and investigation of the reality of POPF was difficult. In 2005, an international consensus for the definition of POPF was developed by the International Study Group of Pancreatic Fistula (ISGPF). Thereafter, further data were collected and the definition was updated in 2016. [1)] POPF occurs in 19% of cases after pancreaticoduodenectomy and in 20%–30% of cases after distal pancreatectomy. [1-2] Treatment of POPF mainly includes surgical, percutaneous and more recently endoscopic procedures, while mortality rates following percutaneous and surgical procedures were not acceptable (14.1% and 35.9%, respectively). [3] The newest strategy for POPF is based on a step-up approach, namely, from minimally invasive endoscopic/percutaneous treatment to invasive surgical treatment.[4] Meanwhile, there has been no evidence of whether endoscopic and percutaneous treatments are comparable or not. Endoscopic procedures are classified as transpapillary and transmural methods due to the approach routes, and their clinical success rates are 75%–100% and 82%–100%, respectively. [4] The approach is selected according to various factors including with/without communication to the main pancreatic duct, with/without formation of a mature wall of collected fluid, and distance between the POPF and the gastrointestinal tract. POPF with a mature wall of collected fluid, namely firmly capsulated POPF, in contact with the gastrointestinal wall is one of appropriate candidates for endoscopic ultrasonography-guided drainage (EUSD), for which we attach most importance for performance of one-step EUSD with a stent. Meanwhile, Tamura et al. also reported the effectiveness of endoscopic ultrasound-guided drainage (EUS-TD) for noncapsulated postoperative pancreatic collection with a 7-Fr. endoscopic nasobiliary drainage tube followed by internalization in another session as a two-step approach. [5]

There have been a few studies including the study by Tamura et al. in which both clinical outcomes of POPF by endoscopic ultrasonography (EUS)-guided and percutaneous treatments were evaluated [3-6], although most reports have shown the results for only either treatment. Tamura et al. revealed that the time to clinical resolution after the procedure was significantly shorter in the EUS-TD group than in the percutaneous drainage (PCD) group (14 versus 26 days; $p < 0.0001$), and Jürgensen et al. also showed that EUSD could lead to an earlier resolution of POPF compared with PCD (8 days vs. 25

days; $p < 0.0001$).[5, 6]

In this study, we aimed to clarify the clinical outcomes of a strategy for postoperative pancreatic fistula with endoscopic ultrasonography-guided and percutaneous drainage based on the wall status of fluid collection and to reveal the efficacy of one-step EUSD with a stent for POPF with a mature wall. This multicenter observational study especially focused on POPF after left-sided pancreatectomy, including a majority of distal pancreatectomies, for simplification.

Materials and methods

Study design

A multicenter retrospective observational study was designed for the aim.

Patients

From January 2012 to September 2017, patients who underwent distal pancreatectomy or left-sided pancreatic resection including central resection or enucleation for pancreatic diseases and developed postoperative pancreatic fistula were searched in the prospectively collected database of four leading institutions (Hokkaido University Hospital, Sapporo Medical School of Medicine, Teine-Keijinkai Hospital and Kin-ikyo Chuo Hospital) in the Hokkaido Pancreatic Cancer Study group (HOPS). Among 336 patients who underwent left-sided pancreatectomy, 90 patients developed grade B or C POPF, as defined by ISGPF and were retrospectively analyzed (Fig. 1). This study was approved by the ethics committee of Hokkaido University Hospital (approval number 018-0086) and by each participating institution and was performed in accordance with the Declaration of Helsinki. All patients or their families gave agreement for enrollment in this study with an opt-out form.

Percutaneous/endoscopic ultrasonography-guided drainage

A grade B/C POPF was treated by EUSD and PCD. Selection of EUSD or PCD was performed according to a strategy based on whether the POPF had a mature wall of collected fluid in contact with the gastrointestinal tract (Fig. 1); in the case of POPF with such a mature wall (Fig. 2a), EUSD was performed, while in the case of POPF with an immature wall (Fig. 2b) or with collected fluid not in contact with the gastrointestinal tract on ultrasonography (US), computed tomography (CT) or magnetic resonance imaging (MRI), PCD was performed.

EUSD was performed using a linear echoendoscope (UCT-240 or UCT-260, Olympus Medical Systems, Tokyo, Japan) with a 19-gauge fine-needle aspiration needle (Echotip, COOK medical; Sonotip®, Medi-Globe GmbH, Germany; Expect™, Boston Scientific, USA) and a 0.025-inch guidewire (Visiglide 2™, Olympus Medical Systems, Japan; M-through™, Medico's Hirata, Japan; PathCourse™, Boston Scientific, USA). Under EUS guidance, skilled endoscopists punctured the POPF and aspirated leaked pancreatic juice. Subsequently, except for cases with aspiration alone, contrast medium was injected, a guidewire was inserted via a needle, the fistula was dilated with a diathermic dilator, and a partially/fully covered metal stent (MS)/double pigtail-shaped plastic stent (PS) was placed in a one-step process (Fig. 2c). In some cases, a nasal tube (external tube) was simultaneously placed with a plastic stent in the same session as a one-step approach.

PCD was performed under fluoroscopy, ultrasonography or CT guidance by skilled radiologists. After puncture, aspiration and contrast medium injection, a 0.035-inch guidewire was inserted, and finally a single/multiple 8-, 10-, or 12-Fr drainage tubes were placed. When POPF was located near the site of operatively placed drains, reposition of the drains or addition of drainage tubes was also performed (Fig. 2d). In many cases, PCD was performed in multiple sessions as a multi-step approach.

Definitions

POPF was defined and classified according to ISGPF—for diagnosis of POPF, the amylase level in any measurable volume of drain fluid on or after postoperative day 3 should exceed 3 times the upper limit of normal serum amylase level for each institution threshold and the fluid should impact on the clinical course with intervention. [1] Grade B POPF was defined as a condition that requires persistent drainage for > 21 days, reposition of the operatively placed drains, angiographic procedures, or percutaneous/endoscopic interventional drainage. Grade C POPF was defined as a condition necessary for reoperation or that leading to organ failure or death.

In this study, left-sided pancreatectomy included standard distal pancreatectomy, central pancreatectomy, distal pancreatectomy with celiac artery resection, or enucleation of the tumor in the pancreatic body/tail.

A mature wall of collected fluid associated with POPF was defined as a wall completely/almost encompassing collected fluid and having a thickness of around 1 millimeter or a few millimeters, as detected by CT or MRI (Fig. 2a). Contact between the wall and the gastrointestinal tract was defined as a point or side where the distance between them was null on CT or MRI. Evaluation of the mature wall and the contact was performed by expert gastroenterologists with more than 10 years' experience in each institution.

Clinical success of the treatment of POPF was defined as $\leq$50% decrease in the POPF size and disappearance of hematological inflammatory response (elevated white blood cell count of blood or serum

C-reactive protein level) or symptoms. Resolution of POPF was defined as disappearance of POPF, disappearance of drainage pancreatic juice, or successful drain tube/stent removal without symptoms thereafter. Because the clinical courses of POPF are frequently complex, the criteria for drain tube/stent removal could not been defined in this study.

Study outcomes

The primary outcome measures were technical and clinical success rates and resolution rates. The secondary outcome measures were patient characteristics, procedure characteristics, white blood cell count of blood and serum C-reactive protein level before and after EUSD/PCD, perioperative data including the surgical method, time from surgery to intervention, and time from intervention to discharge/POPF resolution/stent or tube removal and AEs related to the intervention.

Statistical analysis

Categorical and continuous data were expressed as proportions and means ± SD, respectively. Categorical data were examined using the χ^2 test. The Mann–Whitney *U* test was used to compare quantitative data. Kaplan–Meier analysis with the log-rank test was used to analyze time from intervention to POPF resolution/stent or tube removal. These tests were performed with R software version 3.3.2 (http://www.r-project.org/), and the results were regarded as significant if $P < 0.05$.

Results

Patient characteristics

Among the 336 patients who underwent left-sided pancreatic resection 90 (27%) patients developed POPF and underwent endoscopic intervention (17/336: 5%) or percutaneous intervention (73/336: 22%) for treatment (Fig. 1). Characteristics of the 90 patients included in this study are shown in Table 1. Fifty-seven patients were male and the mean of age of the patients was 64.4 years. The most frequent surgical design was open in 80 cases (88.9%), the most frequent surgical procedure was standard distal pancreatectomy in 68 cases (75.6%), the most frequent pancreatic stump closure was stapler in 63 cases (70%), and the most frequent disease was pancreatic cancer in 47 cases (52.2%). Surgeons placed intraoperative drains in all patients. Seventeen patients underwent EUSD and 73 patients underwent PCD.

All of the 17 patients in the EUSD group had grade B POPF, while 72 patients had grade B POPF and 1 patient had grade C POPF in the PCD group (Table 2). There was no significant difference between disease frequencies in the two groups.

Technical and clinical success rates and resolution rates

The technical success rates were 100% in both the EUSD and PCD groups. The clinical success rate in the EUSD group was 100%, while that in the PCD group was 98.6% (Table 3). The resolution rates were 100% in the EUSD group and 98.6% in the PCD group. In the EUSD group, 13 POPFs disappeared and four POPFs effectively shrunk, while 59 POPFs disappeared and 12 POPFs effectively shrunk in the PCD group. In one patient with grade C POPF in the PCD group, severe bleeding from the superior mesenteric artery due to continuous pancreatic juice leak, liver failure and fatal disseminated intravascular coagulation occurred (day 46).

Secondary outcomes

Procedure characteristics are shown in Table 3. Two cases in the EUSD group and one case in the PCD group underwent aspiration alone without stent/tube intubation. In the EUSD group, 10-mm partially/fully covered MSs with lengths of 50-80 mm were placed in seven cases and a 16-mm MS with a length of 30-mm length was placed in two cases. A single MS/PS was used in eight/four cases, simultaneous combination of an MS and PS was used in one case, multiple PSs were used in two cases, and simultaneous combination of a PS and a nasal tube was used in five cases. In the PCD group, external tubes were used in all cases: a single tube in 67 cases and multiple tubes in five cases. A new puncture for drainage of the POPF was performed in four cases and operatively placed drain exchange or additional drain placement via the same site was done in 69 cases in the PCD group. Puncture sites in the EUSD group were all in the stomach: 15 in the body, 1 in the antrum, and 1 in the fornix. Puncture or drain exchange sites in the PCD group included 30 sites in the epigastrium, 25 sites in the left hypochondrium/flank and 19 sites in the right hypochondrium/flank. The numbers of sessions for EUSD/PCD were one, 17/30 cases; two, 0/15 cases; and three or more 0/28 cases, respectively ($P<0.001$). There were six cases with continuous stent intubation (including 1 difficult case for removal), six cases of stent removal at the primary doctor's discretion and three cases with stent natural dislocation in the EUSD group. There was no case with severe bleeding or other events due to continuous stent intubation and no case with recurrence of POPF after stent removal in the present study.

White blood cell count (WBC) and serum C-reactive protein (CRP) level before and after intervention (EUSD/PCD) are shown in Fig. 3. Although WBC before the 1st intervention in the EUSD group was significantly higher than that in the PCD group (p = 0.0469), WBCs after the 1st intervention and CRP levels before and after the 1st intervention were similar in the two groups. In addition, both WBC and CRP were decreased with time after the intervention.

The time from surgery to endoscopic/percutaneous intervention was significantly longer in the EUSD group than in the PCD group (median period: 20 days [interquartile range, 13–157] vs. 11 days [9–16], Fig. 4) (*P*<0.001). The time from intervention to discharge in the EUSD group was significantly shorter than that in the PCD group (median period: 11 days [interquartile range, 9–26] vs 22 days [16–36], Fig. 5) (*P*<0.001). The time from intervention to resolution in the EUSD group was also significantly shorter than that in the PCD group (median period: 10 days [95% confidential interval, 7–24] vs 20 days [16–28], Fig. 6) (*P*<0.001). The time from intervention to stent/tube removal in the PCD group was significantly shorter than that in the EUSD group (median period: 20.5 days [95% confidential interval, 16–28] vs 873 days [53–not applicable], Fig. 7) (*P*<0.001).

AEs related to intervention are shown in Table 4. The rates of AEs in the EUSD and PCD groups were 11.8% and 5.5%, respectively (*P*=0.316). AEs included abdominal pain, fever, abscess and ileus, all of which could be conservatively treated except in one case. One patient died because of the development of a liver abscess with disseminated intravascular coagulation, which could have been caused by the progression of POPF, not by PCD itself.

Discussion

The present study revealed that one-step EUSD with a stent selected for POPF with a mature wall in a strategy based on the wall status of collected fluid can lead to early discharge and resolution and that PCD performed for POPF with an immature wall can lead to a long clinical course including a multistep approach.

In the present study, the rate of POPF development in DP was around 30%, which was similar to that in previous reports. Most patients (81%) underwent PCD because many POPFs developed in the early stage when a mature wall of collected fluid associated with POPF had not been formed. According to a previous report on PCD after acute pancreatitis, one of the predictors of successful PCD was volume reduction of fluid collection. [7] Our unsuccessful case also had continuous pancreatic juice leak and needed continuous drainage (46 days).

Regarding the treatment strategy for POPF, there should be a clear indication, for example, a mature wall of collected fluid treated by one-step EUSD and an immature wall of that treated by PCD. A recent study by Jürgensen et al. also indicated that POPF can be classified as POPF with or without pancreatic fluid collection (PFC), which is similar to our concept.[6] Their results revealed that the treatment paths were different for POPF with and that without PFC (EUSD/PCD frequency with PFC of 29/48% vs. 16/64% without PFC) and that EUSD could lead to an earlier resolution of POPF compared with PCD regardless of PFC (8/4 days after EUSD with/without PFC vs 25/51 days after PCD with/without PFC). [6] Considering their results and our results, we should assign the highest priority to one-step EUS-guided drainage of POPF. On the other hand, Tamura et al. indicated another effective two-step EUSD strategy for noncapsulated postoperative pancreatic collection with an external drainage tube followed by internalization.[5] Fundamentally, POPFs with and without obvious PFC are different in terms of clinical status: at an early stage of POPF, in the condition of simple pancreatic juice leak without a mature wall/fluid collection, it is difficult to newly drain a POPF by one-step EUS-guided intervention due to difficulties in detection and thus potential perforation; at a late stage of POPF, it is a closed cavity with a mature wall in many cases, which can be easily targeted and internalized by EUS in a one-step process, or rarely an obvious fluid collection treated by EUSD with the two-step process. A previous study by Denzer et al. indicated effective one-step EUSD with a PS for early-stage POPF with PFC without a mature wall in some cases. [8] Thus, the efficacy and safety of one-step EUSD with a PS for POPF without a mature wall needs to be evaluated in many cases hereafter. One-step EUSD for POPF would be more beneficial than two-step EUSD from the viewpoint of burden due to endoscopic procedures on patients.

It is unclear whether the stent should be removed after treatment of POPF. Each treatment option has worrisome events including recurrence of POPF after stent removal and bleeding from vessels near the site where the stent edge is in contact. [9-11] Although there was no case with adverse events due to continuous stent intubation and no case with recurrence of POPF after stent removal in the present study, considering the potential risk of severe bleeding compared with recurrence of POPF, stent removal should be generally recommended. Although the timing of stent removal is not standardized, 3 months after stent placement is considered reasonable based on a Spanish nationwide registry, which indicated a high rate of delayed bleeding 3–6 months after drainage. [12]

Three types of inserted stents have been used via one-step EUS-guided intervention for POPF. According to a recent retrospective study comparing a plastic stent (PS), a fully-covered self-expandable metal stent (FCSEMS) as used in our study, and a lumen-apposing metal stent (LAMS). The technical success rates (93.5% vs 96.4% vs 94.3%, P = 1.000) and treatment success rates (84.6% vs 85.2% vs 89.2%, P = 0.763) were similar for the PS, FCSEMS, and LAMS. With regard to major adverse events, four patients (FCSEMS: n = 2 and LAMS: n = 2) with pseudoaneurysms developed severe bleeding in the metal stent groups, while four patients developed mild bleeding in the PS group. [13] Apart from that, another advantage of a PS is low cost compared with the cost of an MS. On the other hand, the advantage of an MS is a large diameter which would prevent early obstruction by unexpected bleeding or undetected sludge by images compared with a PS. Although the best stent in one-step EUSD for POPF without debris and necrotic tissue in collected fluid might be a PS, this needs to be validated by a randomized controlled study.

AEs related to EUSD and PCD in the present study were tractable and acceptable, and their frequencies were similar to those reported previously (9.4% vs 13.3%, P = 0.68).[14] However, the details of AEs are different in the previous study and our study: the main AE in our study was abscess, while the main AE in the previous study was bleeding. Although the reason for this difference is unclear, it is difficult to strictly differentiate the abscess from that caused by progression of POPF in our study.

There are some limitations in our study. First, this study was a retrospective study and the selection of EUSD and PCD as an intervention was based on the wall status in our study group (HOPS).

Thus, the backgrounds of patients in the EUSD group and PCD group were different. However, such a selection is truly practical and reflects the difficulty of conducting a randomized controlled trial regarding intervention for POPF, which is very diverse and complex. Second, we focused on POPF after left-sided pancreatectomy alone. Therefore, our results cannot be extrapolated to interventions for POPF after pancreatoduodenectomy and those should be evaluated in a future study. Third, the number of patients in the EUSD group was small. Fourth, we did not perform the two-step EUSD strategy. To overcome the two limitations, a randomized controlled trial comparing one-step EUSD with two-step EUSD with a large number of patients is warranted.

In conclusion, a drainage strategy for postoperative pancreatic fistula after left-sided pancreatectomy based on the wall status of collected fluid is appropriate.

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Conflicts of interest

The authors have no conflicts of interest to declare that are relevant to the content of this article.

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Table 1. Patient characteristics

N=90

Male/female	57/33
Age (years) (median, ±SD)	64.4 (±13.5)
Surgical design (open/laparoscopic)	80/10
Surgical procedure	
Standard DP	68
Central resection	11
DP-CAR	8
Others*	3
Pancreatic stump closure	
stapler/suture/patch/combination/nothing	63/14/0/9/4
Disease	
Pancreatic cancer	47
Neuroendocrine tumor	21
IPMN	10
Others	12

SD, standard deviation; DP, distal pancreatectomy; DP-CAR, distal pancreatectomy with celiac artery resection; IPMN, intraductal papillary mucinous neoplasm

*Others include two DP with enucleation and one DP with partial gastrectomy.

Table 2. Patient characteristics in the EUSD and PCD groups

	EUSD n = 17	PCD n = 73	*P* value
POPF size (mm)	69 (17-124)	NA	
POPF grade B/C	17/0	72/1	1
Disease			
Pancreatic cancer	7	40	0.719

Neuroendocrine tumor	5	16
IPMN	2	8
Others	3	9

EUSD, endoscopic ultrasonography-guided drainage; PCD, percutaneous drainage; POPF, postoperative pancreatic fistula; NA, not assessed; IPMN, intraductal papillary mucinous neoplasm

Table 3. Procedure characteristics

	EUSD n = 17		PCD n = 73		*P* value
Technical success (%)	100		100		NS
Clinical success (%)	100		98.6		NS
Resolution rate (%)	100		98.6		NS
Disappeared/shrunk	13/4		59/12		
Intubation/aspiration	15/2		72/1		
Placed internal stent					
MS/TS	9#/7#		0/0		
(MS ϕ10-/16-mm, TS ϕ7-Fr.)	(7/2, 7)				
Single/multiple	12/3		-		
Placed external tube	5##		72		<0.001
Single/multiple	5/0		67/5		
Puncture/drain exchange	17/0		4/69		
Site	Gastric body	15	Epigastrium	30	
	Antrum	1	L-hypochondrium/flank	25	
	Gastric fornix	1	R-hypochondrium/flank	19	
Number of session 1/2/3≤	17/0/0		30/15/28		<0.001
Stent removal/natural dislocation	6/3		-		

EUSD, endoscopic ultrasonography-guided drainage; PCD, percutaneous drainage; NS, not significant; Sx, surgery; MS, metal stent; TS, tube stent; L, left; R, right; #duplicate; ##All external tubes were nasal tubes and combined with a plastic stent.

Table 4. Adverse events

	EUSD n = 17	PCD n = 73	*P* value
Total	2 (11.8%)	4 (5.5%)	0.316
Abdominal pain	1*	0	
Fever	1*	0	
Liver abscess with DIC	0	1	
Retroperitoneal abscess	1	2	
Ileus	0	1	

EUSD, endoscopic ultrasonography-guided drainage; PCD, percutaneous drainage; DIC, disseminated intravascular coagulation; *Duplicate

Figure legends

Fig. 1

Flow diagram of study participants according to the strategy for postoperative pancreatic fistula based on the wall status of collected fluid. POPF, postoperative pancreatic fistula; IVT, intervention = drainage

Fig. 2

(a) A mature wall completely encompassing collected fluid due to postoperative pancreatic fistula (POPF) detected by CT (arrow). (b) An immature wall not encompassing collected fluid due to POPF on CT (arrow). (c) Endoscopic ultrasonography-guided drainage with a metal stent. (d) Percutaneous drainage with drain tube reposition.

Fig. 3

White blood cell counts (WBCs) and serum C-reactive protein (CRP) levels before and after the 1st intervention (mean + standard deviation). Although WBC before the 1st intervention in the EUSD group was significantly higher than that in the PCD group (*P = 0.0469), WBC after the 1st intervention and CRP levels before and after the 1st intervention were similar in the two groups. EUSD, endoscopic ultrasonography-guided drainage; PCD, percutaneous drainage.

Fig. 4

Time from distal pancreatectomy to intervention in the endoscopic ultrasonography-guided drainage (EUSD) group and that in the percutaneous drainage (PCD) group. Time was significantly longer in the EUSD group than in the PCD group (median period: 20 days vs. 11 days, *P < 0.001).

Fig. 5

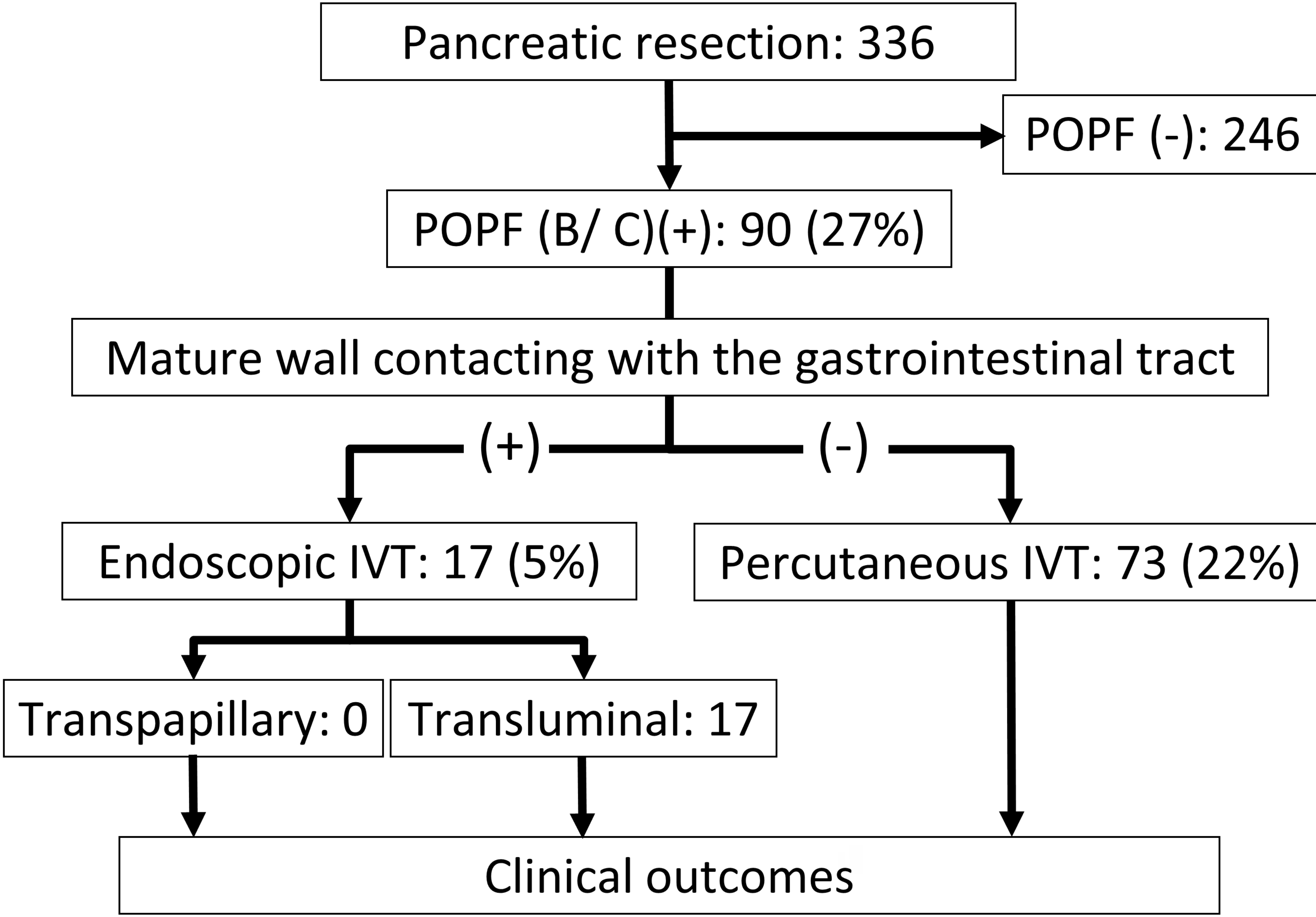
Time from intervention to discharge in the endoscopic ultrasonography-guided treatment (EUSD) group and that in the percutaneous treatment (PCD) group. Time was significantly longer in the EUSD group than in the PCD group (median period: 22 days vs. 11 days, *P < 0.001).

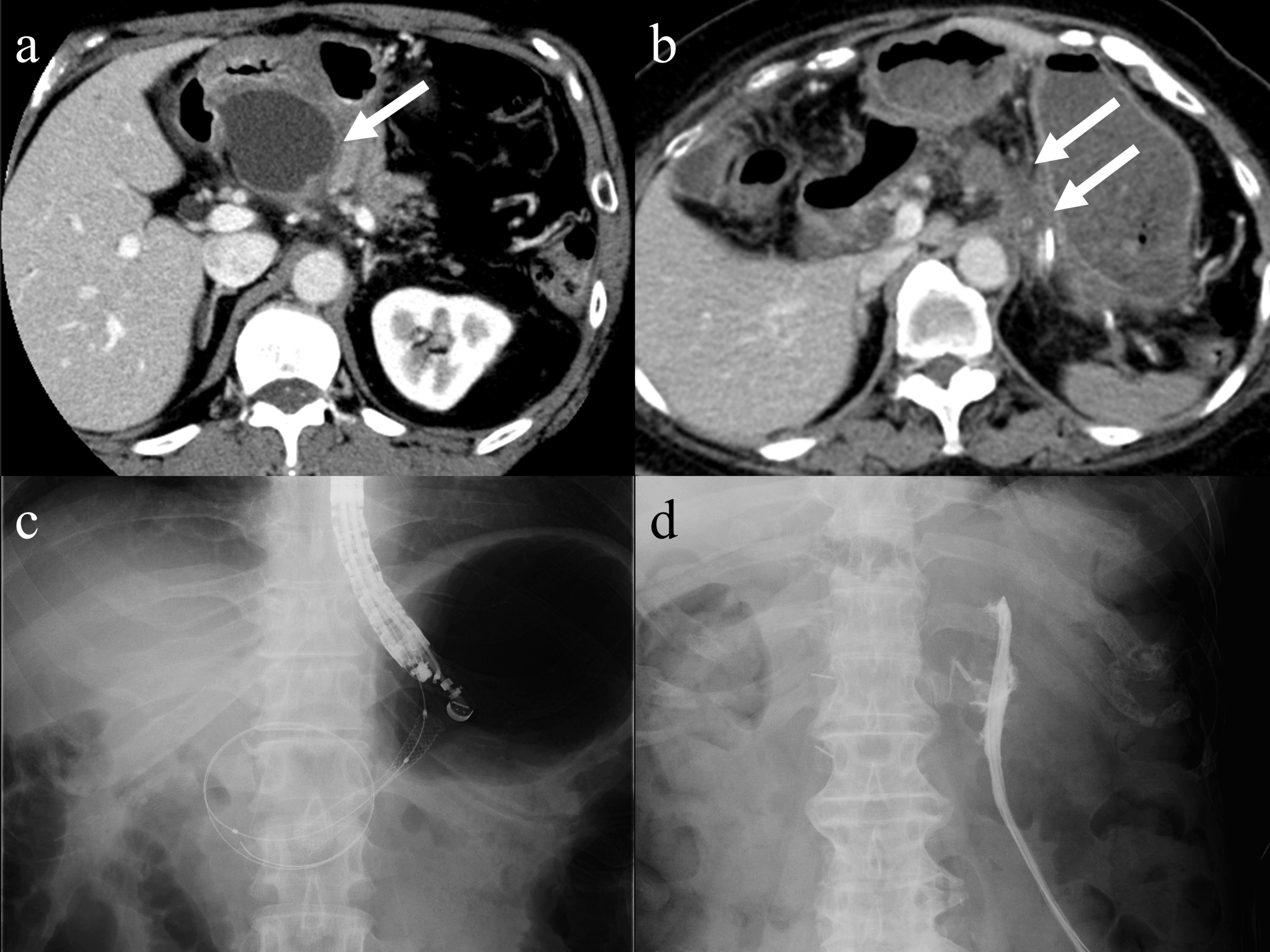
Fig. 6

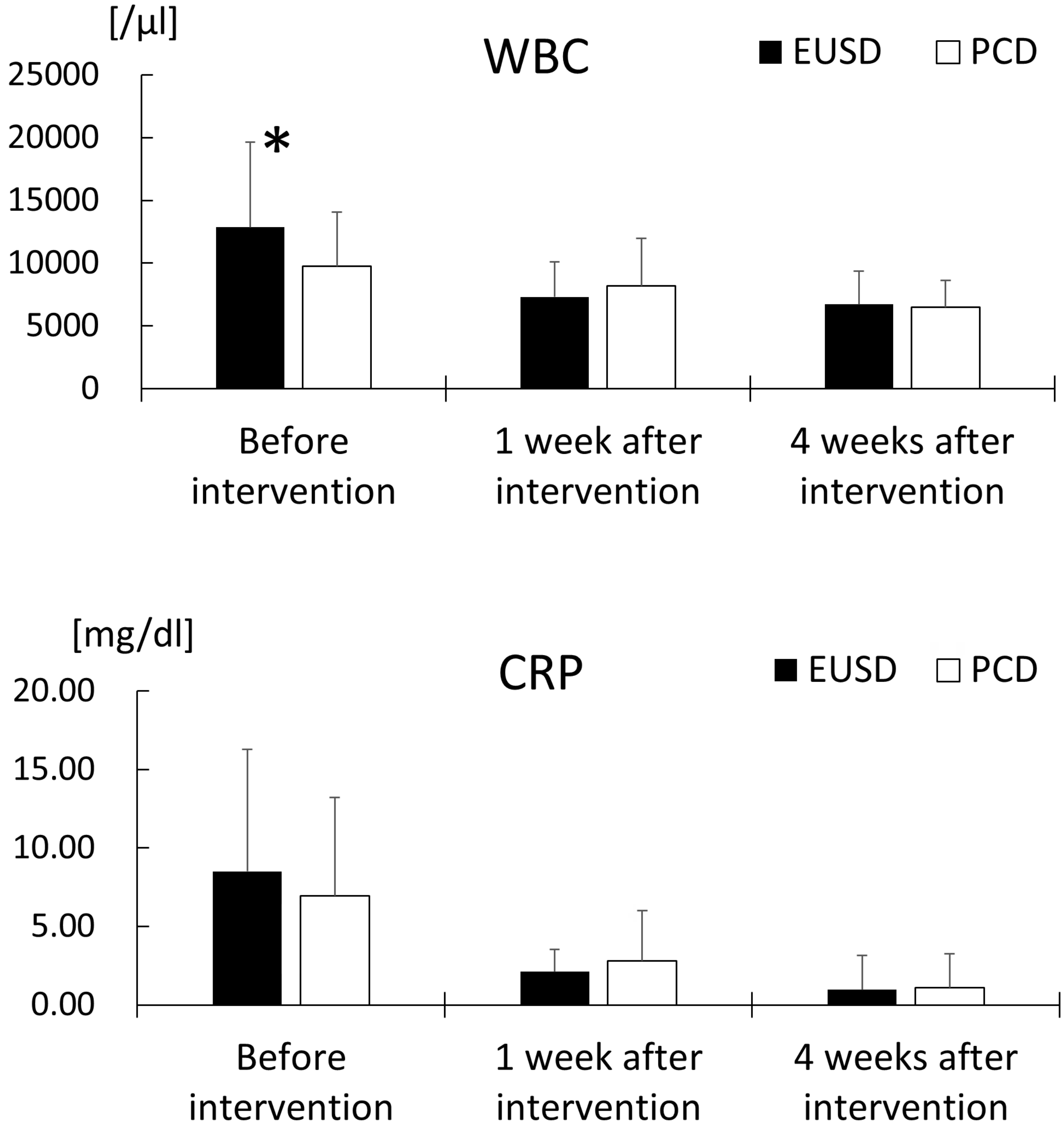
Kaplan-Meier probability curve of postoperative pancreatic fistula (POPF)-related problems. Time from intervention to resolution in the EUSD group was also significantly shorter than that in the PCD group (median period: 10 days vs 20 days) (*P < 0.001).

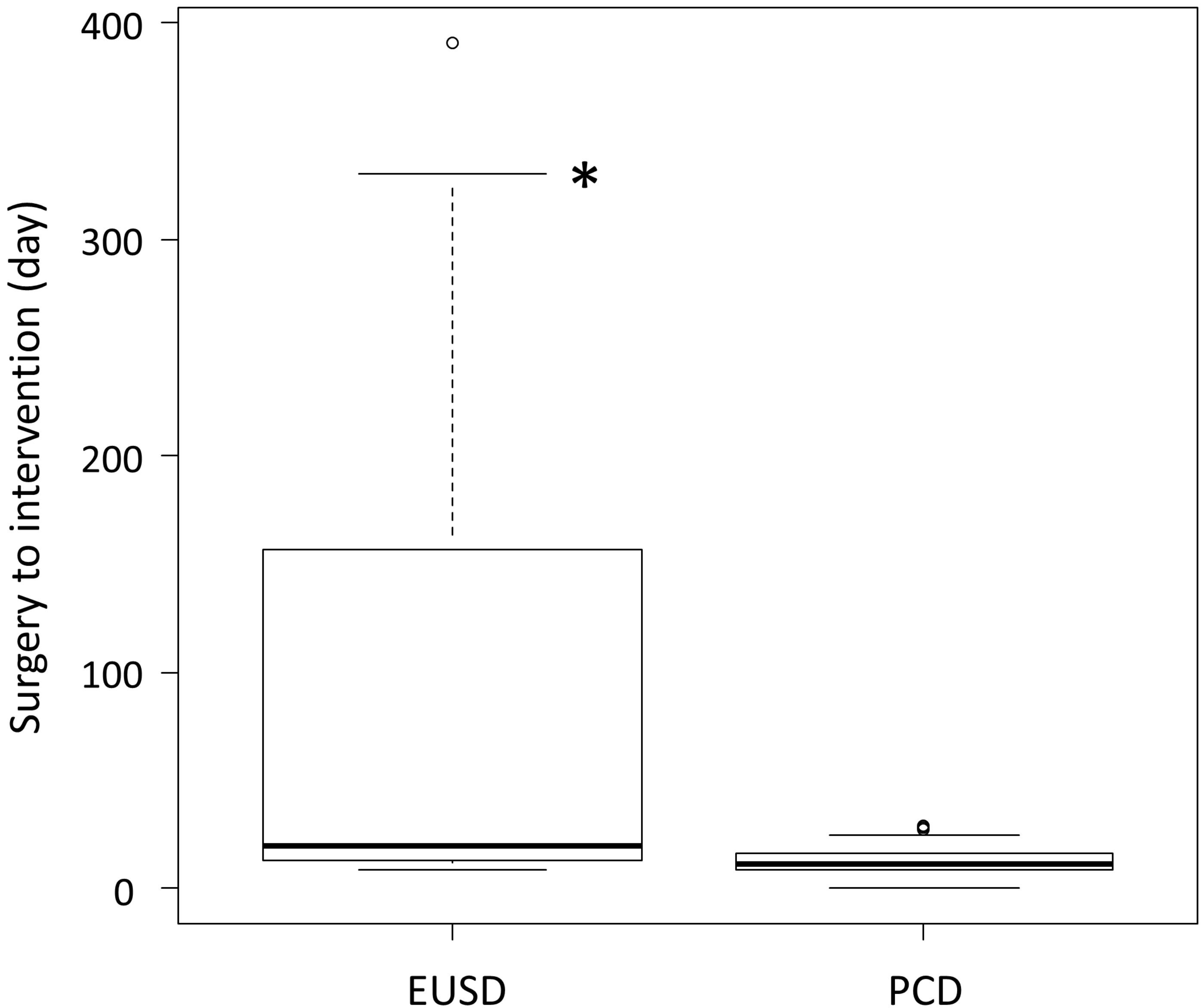
Fig. 7

Kaplan-Meier probability curve with stent/tube intubation. Time from intervention to stent/tube removal in the PCD group was significantly shorter than that in the EUSD group (median period: 20.5 days vs 873 days) (*P < 0.001).

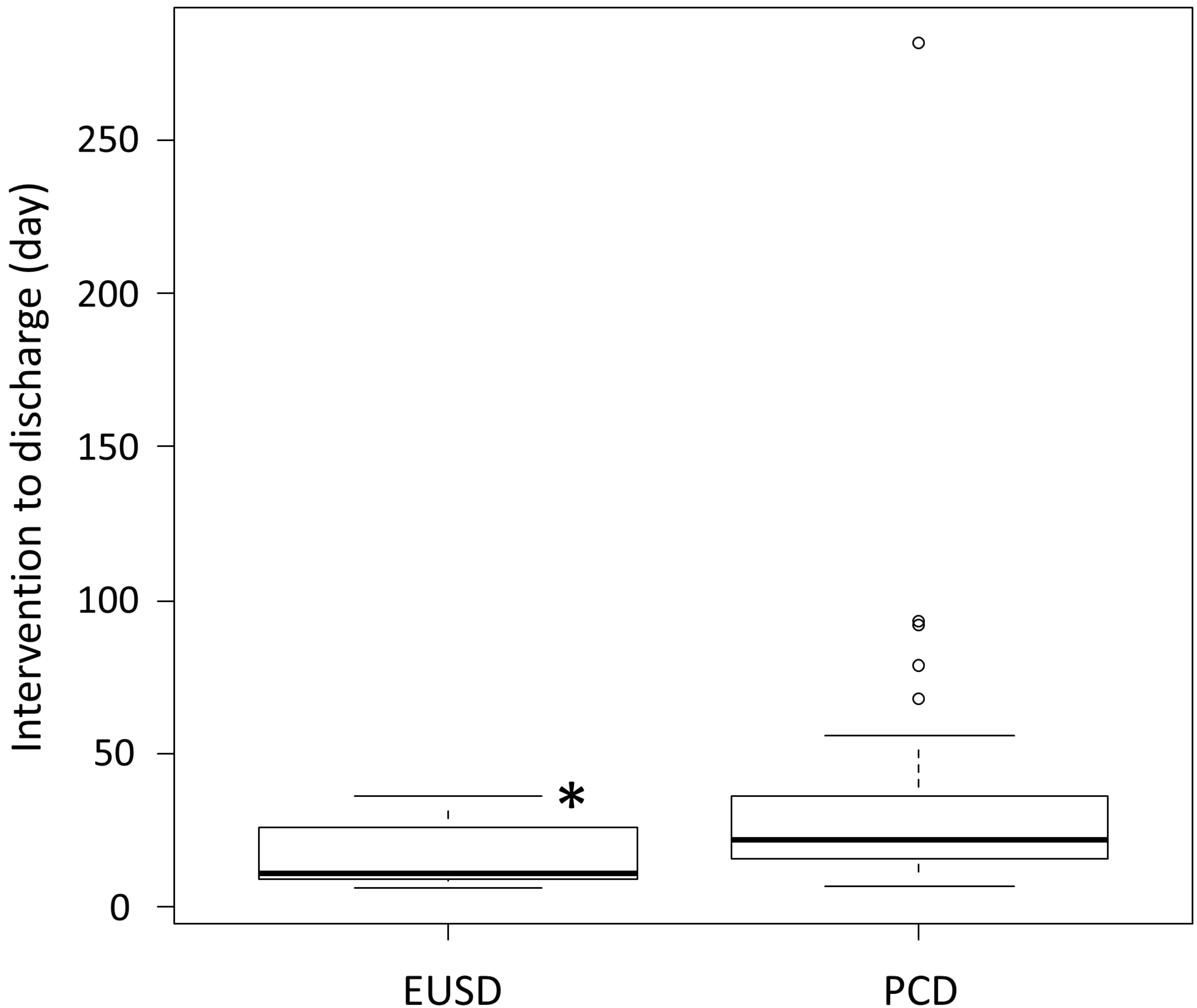

Pancreatic resection: 336
POPF (-): 246
POPF (B/ C)(+): 90 (27%)
Mature wall contacting with the gastrointestinal tract
(+)
(-)
Endoscopic IVT: 17 (5%)
Percutaneous IVT: 73 (22%)
Transpapillary: 0
Transluminal: 17
Clinical outcomes


a
b
c
d

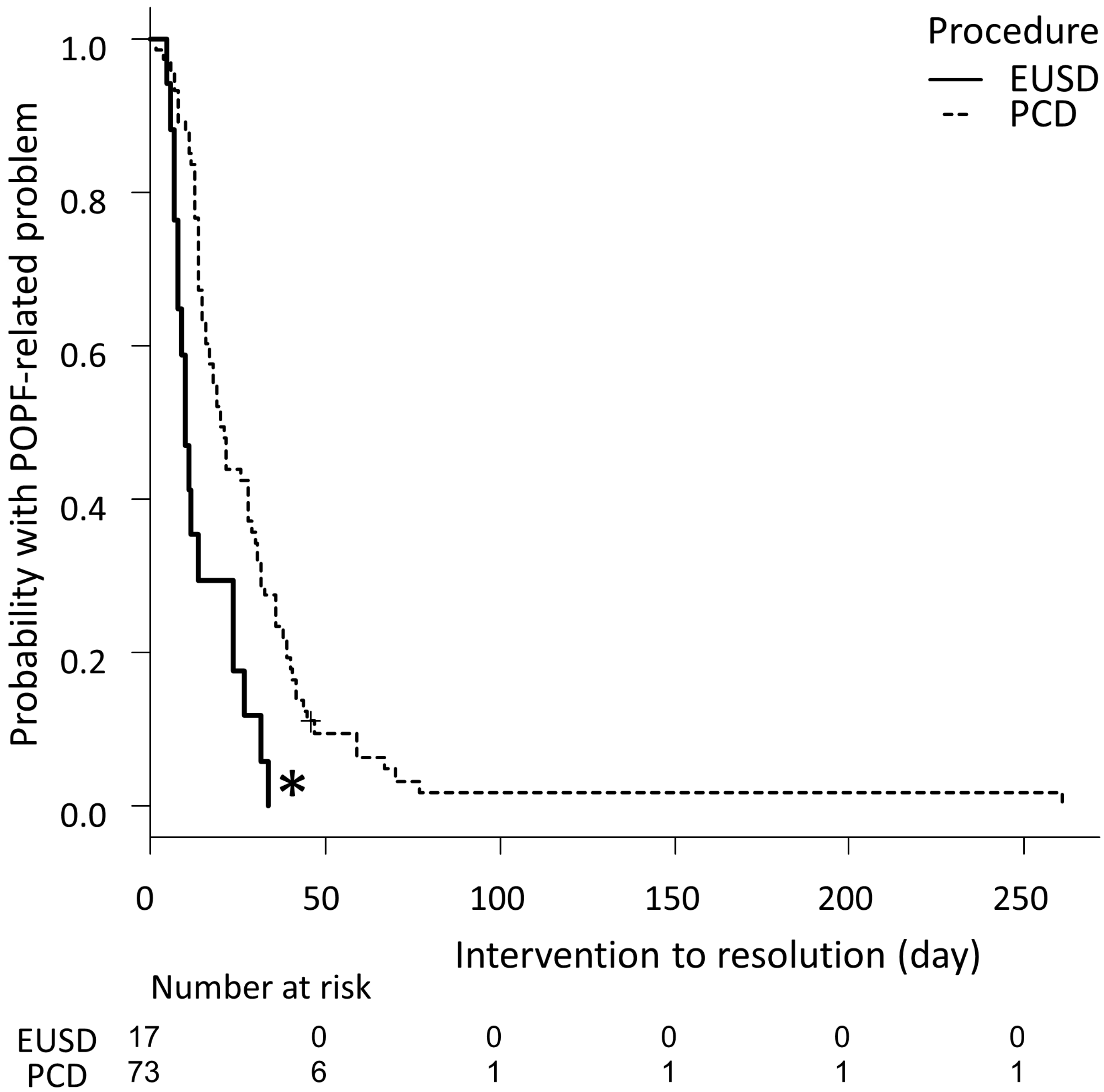

[/μl]
WBC
EUSD
PCD
25000
20000
15000
10000
5000
0
*
Before intervention
1 week after intervention
4 weeks after intervention
[mg/dl]
CRP
EUSD
PCD
20.00
15.00
10.00
5.00
0.00
Before intervention
1 week after intervention
4 weeks after intervention



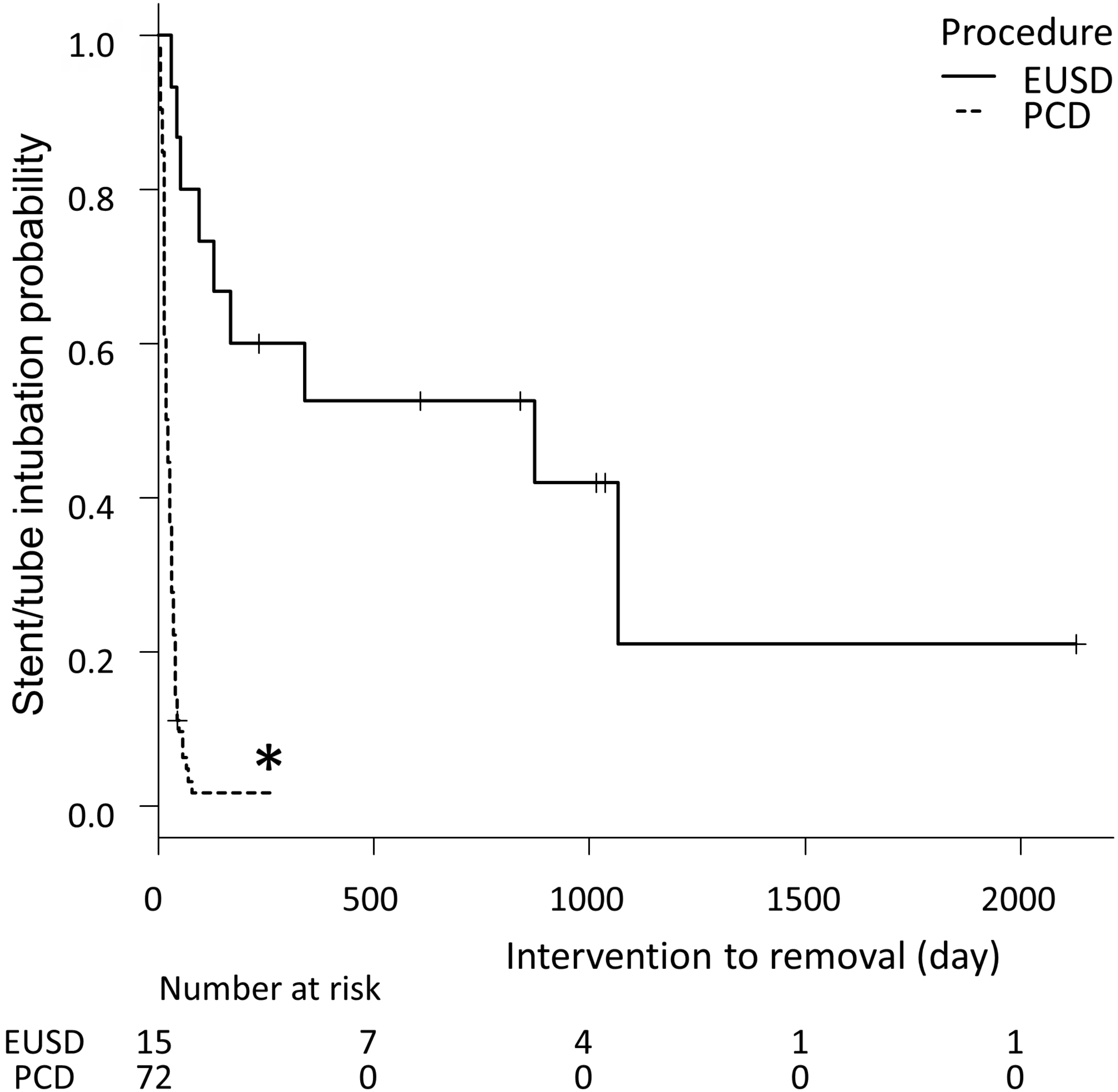
Surgery to intervention (day)
400
300
200
100
0
*
EUSD
PCD



Intervention to discharge (day)
250
200
150
100
50
0
*
EUSD
PCD



Procedure
EUSD
PCD
Probability with POPF-related problem
1.0
0.8
0.6
0.4
0.2
0.0
*
0
50
100
150
200
250
Intervention to resolution (day)
Number at risk
EUSD 17 0 0 0 0 0
PCD 73 6 1 1 1 1



Procedure
EUSD
PCD
Stent/tube intubation probability
1.0
0.8
0.6
0.4
0.2
0.0
*
0
500
1000
1500
2000
Intervention to removal (day)
Number at risk
EUSD 15 7 4 1 1
PCD 72 0 0 0 0