Surgery 172 (2022) 265–272

Contents lists available at ScienceDirect

Surgery

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

Drain use in pancreatic surgery: Results from an international survey among experts in the field

Ilaria Pergolini, MD[a,c,d], Stephan Schorn, MD[a,c], Rüdiger Goess, MD[a,c], Alexander R. Novotny, MD[a,c], Güralp O. Ceyhan, MD[b], Helmut Friess, MD[a,c], Collaborators from International Pancreatic Surgery Centers, Ihsan Ekin Demir, MD, PhD[a,b,c,d,e,*]

[a] Department of Surgery, Klinikum rechts der Isar, Technical University of Munich, School of Medicine, Munich, Germany
[b] Department of General Surgery, HPB-Unit, School of Medicine, Acibadem Mehmet Ali Aydinlar University, Istanbul, Turkey
[c] German Cancer Consortium (DKTK), Partner Site Munich, Munich, Germany
[d] CRC 1321 Modelling and Targeting Pancreatic Cancer, Munich, Germany
[e] Else Kröner Clinician Scientist Professor for Translational Pancreatic Surgery, Munich, Germany

ARTICLE INFO

Article history:
Accepted 23 November 2021
Available online 5 January 2022

ABSTRACT

Background: Drain use in pancreatic surgery remains controversial. This survey sought to evaluate habits, experiences, and opinions of experts in the field on the use of drains to provide interesting insights for pancreatic surgeons worldwide.

Methods: An online survey designed via Google Forms was sent in December 2020 to experienced surgeons of the International Study Group for Pancreatic Surgery.

Results: Forty-two surgeons (42/63, 67%) completed the survey. During their career, 74% (31/42) performed personally >500 pancreatic resections; of these, 9 (21%) >1,500. Sixty-nine percent of the respondents (29/42) declared to always use drains during pancreatic resections and 17% (7/42) in >50% of the operations. For these participants, the use of drains does not increase but reduces the risk of pancreatic fistula and other complications, and more importantly, helps to detect them earlier and manage them better. By contrast, 2 surgeons (5%) declared to never apply drains, whereas other 4 (10%) use drains only in selective cases, deeming that drains increase the risk of infection and other complications. When applied, drains are managed very heterogeneously as for the type of drains, enzyme testing, and removal schedules. Four participants declared to practice continuous irrigation. Twenty-two surgeons (55%) remove drains routinely within the third post-operative day, other 11 (27.5%) only in selected cases, whereas 7 (17.5%) normally keep drains longer.

Conclusion: Despite plenty of publications on this topic, drain management in pancreatic surgery remains very heterogeneous. Safety and the surgeon's personal experience seem to play a determining role.

Introduction

The development of pancreatic fistula (POPF) still represents a frequent event after pancreatic resection (15%–45%), which can lead to serious complications (eg, fluid collection, infection, bleeding) affecting patient's morbidity and mortality.[1] After decades and plenty of publications, the use of drains in pancreatic surgery still remains a challenging and controversial topic. For a long time, pancreatic surgeons have considered drains as a valuable ally to prevent, monitor, and manage POPF and subsequent complications.[2] The rationale for their use after pancreatic resections is based on draining intra-abdominal fluids (eg, pancreatic juice, bile), preventing their accumulation and subsequent complications, such as infections, erosions, and bleeding,[2] and, most importantly, allowing to early detect and monitor them. However, since the 1990s, the utility and safety of drains have been questioned and the use of drains was no longer considered an absolute dogma.[3] After the first attempt by Jeekel et al, several randomized and non-randomized studies reported ~~a~~ similar or even lower complication rates when drains were omitted.[4–8] As a result, some authors

Collaborators from International Pancreatic Surgery Centers: Adham M., Allen P., Andersson R., Barreto G., Bassi C., Bockhorn M., Busch O.R.C., Conlon K., Dejong C.H.C., Dervenis C., Falconi M., Frigerio I., Fusai K., Gianotti L., Grützmann R., Halloran C., Kleeff J., Izbicki J.R., Lou W., Oláh A., Radenkovic D., Shrikhande S.V., Takaori K., Vollmer C., Yeo C.J., Zerbi A.

* Reprint requests: Ihsan Ekin Demir, MD, PhD, Department of Surgery, Klinikum rechts der Isar, School of Medicine, Technical University of Munich, Ismaninger Strasse 22, 81675 Munich, Germany.
E-mail address: ekin.demir@tum.de (I.E. Demir).

https://doi.org/10.1016/j.surg.2021.11.023

suggested desisting from the routine use of drains after pancreatic resections.[9] However, 28 years after the first report that promoted the "no drain" policy, a consensus on the use of drains in pancreatic surgery has not been established yet.

With this survey, we sought to gather habits, experiences, and opinions on the current use of drains during pancreatic resections by experts in the field and the reasons behind their choices. Knowing how and why experts use or do not use drains in pancreatic surgery represents a great opportunity to critically analyze the state of the art and give important insights to surgeons who practice pancreatic surgery worldwide and to the next generations of pancreatic surgeons.

Methods

An online survey designed via Google Forms (https://docs.google.com/forms; Google LLC, Menlo Park, CA) was sent in December 2020 to experienced pancreatic surgeons from different international pancreatic surgery centers. With the goal to provide insights and guidance for pancreatic surgeons worldwide, we decided to send the survey to a selected panel of recognized experts in the field. Depending on the provided responses, the survey proceeded differently; accordingly, the duration of the survey and the total number of questions could differ across participants. No patients were involved or included in the study evaluation, accordingly, no patient's consent was required. Participating in the survey, the colleagues gave their consent to collect data. All questions are shown in Supplementary Content S1. To reduce bias, the survey was completely anonymous and could be filled only once. To avoid missing data, all responses were obligatory. Participants were asked to send separately an e-mail as confirmation of participation after completing the survey if they wished to be named as collaborators.

We collected general information about the participants and their expertise in pancreatic surgery, such as age, years of experience as attending, number of pancreatic resections performed personally, annually, and during their entire career, and institutional volume. Subsequently, we asked questions about drain management, with a focus on the number and type of drains, localization, enzyme and microbiological testing of the drain fluid and blood, and timing and indications for the removal. The use of early drain removal and pancreatic ductal transanastomotic stents was also investigated. We also registered personal opinions and motivations behind the expert's choices.

The data analysis was performed with Microsoft Excel 2019 (Microsoft, Redmond, CA). Data were reported as frequencies with percentage for categorical variables, and median with interquartile range for continuous variables. Variables were processed using IBM SPSS Statistics 22 (IBM Corp., Orchard Road Armonk, NY).

Results

Participants

Sixty-seven percent of the surgeons contacted completed the online survey, with a total of 42 participants (42/63). Table I shows general information regarding the respondents. The median age of the respondents was 58 years (range, 41–72) with a median of years of experience as attending of 22 years (range, 4–43). Thirty-four respondents (81%) reported practicing primarily (>75%) or exclusively hepatopancreatobiliary surgery. At the time of the survey, all participants stated to currently work in hospitals with more than 20 pancreatic resections per year. Of note, 60% (25/42) of respondents declared to work at a referral center where >100 pancreatic resections are performed per year, and even 7 of them (7/42, 17%) at a center with >200 pancreatic resections performed annually. Thirty-six percent (15/42) of the surgeons affirmed to perform personally >50 pancreatic resections per year, while 74% (31/42) declared having performed >500 during the entire career. Remarkably, 21% (9/42) of the respondents reported having carried out >1,500 pancreatic resections globally.

Table I
Characteristics of participants

	N = 42	%
Age, median, range, (y)	58	(41–72)
Years as attending surgeon until now, median, range, (y)	22	(4–43)
Pancreatic resections performed in their department every year		
<20	0	0
20–50	5	12
50–100	12	29
100–150	9	21
150–200	9	21
>200	7	17
Pancreatic resections personally performed every year		
<10	2	5
10–20	6	14.5
20–50	19	45
50–100	9	21
>100	6	14.5
Pancreatic resections personally performed in the entire career		
<100	0	0
100–250	5	12
250–500	6	14.5
500–1,000	16	38
1,000–2,000	9	21
>2,000	4	9.5
Surgeons practicing exclusively/mostly (>75%) HPB surgery		
Yes	34	81
No	8	19
Drain use		
Yes, always (100%)	29	69
Yes, often (>50%)	7	16.5
Yes, but only in selective cases (< 20% or only with "pancreas soft" or uncertain anastomosis)	4	9.5
Not usually (<10%)	2	5
Dislocation rate		
<30%	16	40
30–50%	22	55
>50%	2	5
Continuous irrigation		
No	36	90
Yes, usually	1	2.5
Yes, only in very selected cases (ie, soft pancreas, pancreas divisum, very small main pancreatic duct)	3	7.5
Yes, only in case of reoperation for major complications	0	0

HPB, hepato-pancreato-biliary.

Use of drains

Sixty-nine percent (29/42) of the respondents declared to always use drains during pancreatic resection, and an additional 16.5% (7/42) in >50% of the operations (Table I). Two surgeons (2/42, 5%) asserted to practically never use drains (<10% of cases), whereas other 4 participants (4/42, 9.5%) use them only in very selective cases (<20%; ie, with soft pancreas or uncertain anastomosis; Table I). The use of drains did not depend on the surgeon's age or experience, nor on the center volume.

Overall, 56% (20/36) of the respondents who frequently use drains (always or >50% of cases) believe that they might dislocate in

more than 30% of the cases (Table I). Those who apply drainages selectively have less confidence that the drains will remain properly placed than those who use them routinely. All 4 surgeons who use drains selectively, believe that drains dislocate in ≥30% of cases, compared with 71% (5/7) and 52% (15/29) of those who use drains in >50% or in any case, respectively.

Four surgeons (4/42, 9.5%) affirmed to proactively use drains for continuous peritoneal irrigation (Table I). One participant who uses drains frequently (>50%) declared to routinely practice continuous irrigation, whereas the other 3 respondents only in selected cases when a POPF is clinically highly suspected or prophylactically in presence of risk factors for POPF such as soft pancreas, very small main pancreatic duct, or difficult anastomosis.

Management of drains after pancreatic resection

Data on drain management are shown in Table II. Among the 36 participants who use drains routinely or very frequently (> 50%), 7 (7/36, 19%) normally use a Robison drainage, 14 (14/36, 39%) an easy flow or Penrose type, while the remaining 15 (15/36, 42%) a Jackson-Pratt or Blake drain with close suction. During duodenopancreatectomy, 10 respondents (10/36, 28%) affirmed to place only 1 drain, 23 (23/36, 64%) 2, and 3 participants (3/36, 8%) 3 or 4 drains. In distal pancreatectomy, the placement of a single drain is preferred by 72% of participants (26/36), while 10 (10/36, 28%) surgeons reported to usually place 2 drains. Postoperatively, 14 surgeons (14/36, 39%) affirmed to not test routinely amylase or lipase in the blood of resected patients, while 13 respondents (13/36, 36%) assess only amylase, 1 (1/36, 3%) only lipase, and 8 participants (8/36, 22%) both. Except for one respondent, all participants routinely analyze pancreatic enzymes in drain fluid: 28 (28/36, 77%) only amylase, 1 (1/36, 3%) only lipase, and 6 (6/36, 17%) both. Eighteen participants (18/36, 50%) usually analyze pancreatic enzymes in blood and drain fluid simultaneously and 31 (31/36, 86%) apply an internal institutional testing protocol. However, the testing schedule was very heterogeneous, as well as, the cut-off values considered predictive for POPF. Except for 7 participants (7/36, 20%) who assess enzymes in the drain fluid only once, all other respondents declared to test them at least 2 times before drain removal. Twenty-two respondents (22/36, 63%) test enzymes in drain fluid already in the first 2 postoperative days (PODs); the remaining 13 patients from the third POD onward. Overall, testing enzymes on the first and third POD represented the most frequent testing protocol used by 13 participants (13/36, 37%).

At the first measurement after surgery, 5 participants (5/36, 14%) considered predictive for POPF an amylase value in drain fluid 3-fold higher than the serum value; otherwise, the most frequently used amylase cut-off was >1,000 U/L for 7 respondents (7/36, 19%) and >5,000 U/L for other 10 participants (10/36, 28%). At the second measurement after surgery, the cut-off predictive for POPF remained the same for 15 respondents (15/28, 53%), whereas it was lower than the first measurement for 10 participants (10/28, 36%) and higher for the remaining 3 (3/28, 11%).

Only one surgeon (1/36, 3%) stated to routinely perform microbiological exams; all other respondents (35/36, 97%) only run microbiological exams when drain fluid is suspicious for POPF. Most participants (22/36, 61%) are used to remove at least 1 drain within the first 3 PODs: 2 at first POD, 1 at the second POD, and 19 at the third POD. Twelve respondents (12/36, 33%) maintain drains longer, removing them from the fourth POD onward. Two other surgeons (2/36, 6%) declared to not have a specific protocol, but rather remove drains based on amylase value or fluid volume. On the day they intend to remove the drain, 67% of the respondents (24/36) assess pancreatic enzymes in the drain fluid, 8 of them also

Table II
Drain management among the 36 participants who employ drains routinely or very frequently (>50%)

	N	%
Type of drain		
Robinson drainage: passive drain/gravity bag	7	19
Jackson-Pratt or Blake drainage-close suction drain	15	42
Easy-flow/Penrose drainage-passive drain/gravity bag	14	39
Other (description)	0	0
No. of drains placed after pancreaticoduodenectomy		
1	10	28
2	23	64
≥3	3	8
No. of drains placed after distal pancreatectomy		
1	26	72
2	10	28
≥3	0	0
Test for amylase or lipase in the blood		
Yes, only amylase	13	36
Yes, only lipase	1	3
Yes, both (amylase and lipase)	8	22
No	14	39
Test for amylase or lipase in the drain fluid		
Yes, only amylase	28	77
Yes, only lipase	1	3
Yes, both (amylase and lipase)	6	17
No	1	3
Simultaneous test of pancreatic enzymes in serum and drain fluid	18	50
Application of an internal institutional testing protocol	31	86
Usual time-point for first testing amylase/lipase in the drain fluid		
First POD	21	58
Second POD	1	3
Third POD	13	36
Fourth POD	0	0
Fifth POD	1	3
Cut-off for amylase value in drain fluid (first measurement)		
>100 U/L	0	0
>200 U/L	3	8
>500 U/L	7	19.5
>1,000 U/L	7	19.5
>2,000 U/L	3	8
>5,000 U/L	10	28
Not test amylase in the drain fluid	1	3
Other (>3-fold serum amylase)	5	14
Cut-off for amylase value in drain fluid (second measurement)		
>100 U/L	0	0
>200 U/L	4	11
>500 U/L	5	14
>1,000 U/L	10	28
>2,000 U/L	3	8
>5,000 U/L	2	6
Not test amylase in the drain fluid	8	22
Other (>3-fold serum amylase)	4	11
Microbiological analysis of the drain fluid		
Yes, always	1	3
Yes, only when the fluid is suspicious for pancreatic fistula	35	97
No	0	0
Timing for drain removal		
First POD	2	5.5
Second POD	1	3
Third POD	19	53
Fourth or more POD	12	33
Other	2	5.5
Quantity threshold of drain fluid for drain removal		
<20 mL	2	5
<50 mL	5	14
<100 mL	4	11
<200 mL	9	25
<300 mL	6	17
<500 mL	1	3
No threshold	9	25

POD, postoperative day.

assess blood enzyme levels. The most important criteria for drain removal, defined as "important" or "very important" by participants, were the quality of drain fluid and the value of pancreatic enzymes, followed by patient's general conditions. Nine surgeons (9/36, 25%) declared to not consider any volume threshold for drainage removal.

Among the 4 surgeons who use drains only in selected cases, all tested amylase or lipase in drain fluid and blood following internal protocols. Of note, 3 of them usually use passive drains (Robinson or Easy-flow drains) and remove them on the third postoperative day because they believe that drains increase the risk of infection and contamination. By contrast, the remaining respondent declared to place Shirley drain, and keep them 5 days or longer. In case of suspicious drain fluid, a continuous irrigation of the surgical area can be performed, to actively treat POPF and avoid major complications.

Reasons supporting the use of drains

Surgeons who use drains always or in most cases (>50%) were asked why they continue to use them despite the fact that several studies advise to abandoning them (Table III). Here, according to most surgeons (25/36, 69%), drains reduce or do not influence the risk of POPF; by contrast, 6 respondents (6/36, 17%) deemed that drains probably increase the risk of POPF and another 18 participants (18/36, 50%) believe that they increase the risk of infection and contamination. However, these surgeons justified the use of drains as helpful in detecting POPF earlier (31/36, 86%), reducing the risk of major complications (24/36, 67%), and facilitating their management (31/36, 86%). The same reasons were also mentioned as the most important factors in the open-ended questions. Here, 5 participants (5/36, 14%) also cited "tradition" among the reasons for still using drains. One respondent declared to still use drains because even surgeons who have recommended to omit them are actually still using them.

Reasons supporting the "no drain" policy

As shown in Table IV, for the 2 surgeons (2/42, 5%) who never use drains because they do not reduce the risk of POPF, but rather increase the risk of infection and other complications. For the 4 respondents (4/42, 10%) who use drains only in very selected cases (< 20%), they may be helpful for early detection of complications, but, as well, increase the risk of infection or contamination (for 3 of them). For this reason, 3 of these respondents, although using open passive Robinson or Easy-flow drains, remove them on the third postoperative day. By contrast, the remaining respondent usually places Shirley drains and, as mentioned above, keeps them for 5 days or longer to perform, in case of suspicious drain fluid, continuous irrigation for POPF treatment.

Early drain removal

Among the 40 respondents who declared to use drains, either routinely or selectively, 21 surgeons (21/40, 53%) remove drains usually within the third POD, 11 (11/40, 27%) in selected cases,

Table III
Reasons behind the drain management

	Drains always or >50% of cases N = 36 (%)	Drains only in selective cases N = 4 (%)
Drains reduce the risk of POPF		
Yes, drains reduce the risk of pancreatic fistula	2 (5.5)	0 (0)
No, drains increase the risk of pancreatic fistula	6 (17)	1 (25)
No, drains do not influence the risk of pancreatic fistula	23 (64)	3 (75)
I do not know	5 (14)	0 (0)
Drains can help to detect earlier POPF and complications		
Yes	31 (86)	2 (50)
No	1 (3)	0 (0)
Maybe	4 (11)	2 (50)
I do not know	0 (0)	0 (0)
Drains reduces the risk of major complications		
Yes, drains reduce the risk of major complications	24 (67)	1 (25)
No, drains increase the risk of major complication	0 (0)	0 (0)
No, drains do not influence the risk of major complications	11 (31)	3 (75)
I do not know	1 (3)	0 (0)
Drains can help to manage major complications		
Yes	31 (86)	2 (50)
No	1 (3)	1 (25)
Maybe	4 (11)	1 (25)
I do not know	0 (0)	0 (0)
Drains increase the risk of infection/contamination		
Yes, drains increase the risk of infection/contamination	18 (50)	3 (75)
No, drains reduce the risk of infection/contamination	3 (8)	0 (0)
No, drains do not influence the risk of infection/contamination	12 (33)	0 (0)
I do not known	3 (8)	1 (25)
Reasons to use drains (open-ended question). Drains:		
Reduce the risk of pancreatic fistula	5 (14)	0 (0)
Reduce the risk of other complications	16 (44)	1 (25)
Help to detect earlier a pancreatic fistula and other complications	33 (92)	2 (50)
Help to manage complications	24 (67)	1 (25)
Do not increase the risk of fistula	11 (31)	0 (0)
Do not increase the risk of infection and other complications	7 (19)	0 (0)
Are traditionally used in my department	5 (14)	0 (0)
Other (description):Drains are used by groups who published against it	1 (3)	0 (0)

POPF, pancreatic fistula.

whereas 8 respondents (8/40, 20%) normally keep them longer (Tables V and VI).

For these 8 participants (8/40, 20%), early drain removal (less than a third POD) does not reduce the risk of fistula (for 5 of them, 62.5%), infection and contamination (for 6 of them, 75%) or other complications (for 7 of them, 87.5%). In the open-ended questions, the possibility to detect POPF and complications earlier (for 5 respondents, 62.5%) and manage them better (for 6 respondents, 75%) were the most important factors for keeping drains longer. Two respondents mentioned tradition and the use of an institutional protocol testing pancreatic enzymes in drain fluid on the fifth POD as additional reasons for maintaining drains longer.

Among the 11 respondents who selectively remove drains within the third POD, the majority (9 of them, 82%) support this approach as it can reduce the risk of infection and contamination. For the remaining 21 respondents who routinely perform early drain removal, this approach reduces the risk of pancreatic fistula (for 14 of them, 67%) or other complications (for 18 of them, 86%), whereas keeping drains longer may increase the risk of infection or contamination (for 20 of them, 95%). For some respondents, keeping drains longer is also considered not helpful to earlier detect POPF or other complications (for 6 of them, 28%) or better manage them (for 10 of them, 48%). Of note, 2 participants mentioned "patient comfort" and their institutional discharge policy reasons for early drain removal.

Use of pancreatic transanastomotic stents

Forty-three percent (18/42) of the respondents claimed not to use pancreatic transanastomotic stents, whereas 8 (8/42, 19%) participants usually use them, and 16 (16/42, 38%) only place them in selected cases (Table VII). Internal pancreatic transanastomotic stents are applied more frequently than externalized ones (67% vs 33%). Of note, among the 6 surgeons who do not employ drains at all or very selectively, 3 declared to apply pancreatic transanastomotic stents.

Recent studies have suggested that the use of externalized stents might be associated with lower rates of POPF and major complications,[10–12] even though their superiority has not yet been established.[13,14] In this setting, the 34 participants who do not use stents or prefer internal stents were asked about the reasons behind their choice. Here, externalized transanastomotic stents were considered as not helpful to reduce the risk of POPF (for 20 of them, 59%) or other complications (for 13 of them, 38%), but on the contrary, they may increase the risk of POPF, infection and other complications for 7 of them (21%). Overall, 21 respondents (62%) justified their choice as externalized stents are not traditionally used in their institutions. By contrast, among 16 participants (67%) who use internal transanastomotic stents, these devices reduce the risk of POPF (for 9 respondents, 47%) or major complications (for 6 respondents, 38%), can be helpful for performing the pancreatoenteric anastomosis (for 2 respondents, 13%) or are traditionally used in their institution (for 2 respondents, 13%).

Discussion

Our survey revealed that around 85% of the participating surgeons routinely use drains and 50% of them usually remove them within the third POD. Although testing pancreatic enzymes in blood and drain fluid is a common practice performed overall by 65% and 98% of respondents, respectively, time points and cut-off values of testing are extremely heterogeneous. Furthermore, the type and number of drains, and, timing for drain removal vary widely. Overall, among the experts who completed the survey, there was no agreement on drain management, but rather an individual approach. Moreover, analyzing the reasons behind their decisions, it seems that surgeons are driven more by their own experience than by scientific evidence. As we consulted experts in the field working in high-volume hospitals for pancreatic surgery, reading the same literature, collaborating in the same multicentric studies and editing the same guidelines, this heterogeneity in drain management certainly represents the main and most interesting finding of this survey. However, this reflects the still controversial results in the current literature and the unresolved debate on this issue.

As mentioned earlier, since the mid-1930s drains were considered indispensable for the postoperative management in pancreatic surgery, as a useful tool for early detection, monitoring, and management of any fistula or bleeding.[2,9] However, their "reputation" was marred in the 1990s, when some surgeons began to argue that drains not only do not reduce the risk of POPF and complications but, on the contrary, may increase the risk of postoperative morbidity and mortality.[3,4,6–9] Intraperitoneal drainages are suspected to be the cause of erosion and subsequent POPF, bleeding or perforation and, as in communication with outer space, the source of contamination and infection. Patients' discomfort is also counted among the disadvantages.[2] As a result, some surgeons suggested abandoning drains or removing them earlier,[15] sparking an intense debate. To date 3 randomized clinical trials were conducted to compare the postoperative outcomes of pancreatic resections with or without peritoneal drainages. In 2001, Conlon et al first tested the effect of closed-suction drains on postoperative mortality and complications in a randomized study, showing no significant differences in the number or type of complications between the drain and the no-drain groups. However, the study showed that in patients with a drain the incidence of intraabdominal abscesses or collections and fistulas was significantly higher. According to these results, the authors suggested that closed suction drainage should not be considered mandatory or a standard after pancreatic resection.[4] By contrast, several years later, Van Buren et al

Table IV
Reasons behind never using drain management

	Surgeons who never use drains
	N = 2 (%)
Reasons to not use drains (open-ended question). Drains:	
Do not reduce the risk of pancreatic fistula	2
Do not reduce the risk of other complications	1
Do not help to detect earlier POPF and other complications	1
Do not help to better manage complications	1
Increase the risk of pancreatic fistula	0
Increase the risk of infection and other complications	2
Drains are traditionally not used in my department	0
Other (description)	0

Table V
Use of EDR

	Entire cohort (N = 40)	Yes, routinely (N = 21)	Yes, only in very selected case (N = 11)	No, usually not (N = 8)
EDR reduces the risk of pancreatic fistula				
Yes	14 (35)	11 (53)	1 (9)	2 (25)
No	16 (40)	7 (33)	4 (36)	5 (62.5)
Maybe	9 (22.5)	3 (14)	5 (46)	1 (12.5)
I do not know	1 (2.5)	0 (0)	1 (9)	0 (0)
EDR reduces the risk of complications				
Yes	19 (47.5)	16 (76)	2 (18)	1 (12.5)
No	16 (40)	3 (14)	6 (55)	7 (87.5)
Maybe	5 (12.5)	2 (10)	3 (27)	0 (0)
I do not know	0 (0)	0 (0)	0 (0)	0 (0)
EDR reduces the risk of infection/contamination				
Yes	27 (67.5)	18 (85)	8 (73)	1 (12.5)
No	8 (20)	0 (0)	2(18)	6 (75)
Maybe	4 (10)	2 (10)	1 (9)	1 (12.5)
I do not know	1 (2.5)	1 (5)	0 (0)	0 (0)

EDR, early drain removal.

Table VI
Reasons for EDR

	N	%
Reasons for EDR (open-ended question)	32	100
Early drain removal reduces the risk of pancreatic fistula	12	37.5
Early drain removal reduces the risk of other complications	11	34
Keeping drains longer does not help to detect earlier POPF/other complications	10	31
Keeping drains longer does not help to better manage complications	14	44
Keeping drains longer increases the risk of pancreatic fistula	11	34
Keeping drains longer increases the risk of infection/other complications	26	81
Other (description)	2	6
Discharge policy	1	
Patient comfort	1	
Reasons for keeping drains for longer time (open-ended question)		
Early drain removal does not reduce the risk of pancreatic fistula	8	100
Early drain removal does not reduce the risk of other complications	2	25
Keeping drains longer help to detect earlier POPF/other complications	3	37.5
Keeping drains longer helps to better manage complications	5	62.5
Keeping drains longer does not increase the risk of pancreatic fistula	6	75
Keeping drains longer does not increase the risk of infection/other complications	1	12.5
Early drain removal is not traditionally used in my department	2	25
Other (description):	1	12.5
Because institutional testing protocol at third and fifth POD	1	12.5

EDR, early drain removal; POD, postoperative day; *POPF*, pancreatic fistula.

Table VII
Use of transanastomotic pancreatic ductal stents

	N	%
Use of transanastomotic pancreatic ductal stent after pancreaticoduodenectomy		
No, never	18	43
Yes, usually	8	19
Yes, only in selected cases (eg, soft pancreas, small main pancreatic duct, etc)	16	38
Type of transanastomotic pancreatic ductal stent		
Interal stent	16	67
Externalized stent	8	33
Reasons for choosing internal transanastomotic stents	16	100
Reduce the risk of pancreatic fistula	9	47
Reduce the risk of other complications	6	38
Do not increase the risk of pancreatic fistula	3	19
Do not increase the risk of infection and other complications	2	13
Internal stents are traditionally used in my department	2	13
Other (description)	2	13
Reasons for choosing to use externalized transanastomotic stents	8	100
Reduce the risk of pancreatic fistula	7	88
Reduce the risk of other complications	4	50
Do not increase the risk of pancreatic fistula	1	13
Do not increase the risk of infection and other complications	1	13
Externalized stents are traditionally used in my department	0	0
Other (description)	0	0
Reasons for not using externalized transanastomotic pancreatic ductal stents	34	100
Do not reduce the risk of pancreatic fistula	20	59
Do not reduce the risk of infection and other complications	13	38
Increase the risk of pancreatic fistula	2	6
Increase the risk of infection and other complications	7	21
Externalized stents are traditionally not used in my department	21	62
Other (description)	2	6

suspended their randomized study because of increased mortality from 3% to 12% in patients after pancreaticoduodenectomy without drain,[16] concluding that elimination of intraperitoneal drainage increases the frequency and severity of complications in all cases of pancreaticoduodenectomy. In another more recent randomized clinical trial, however, Witzigmann et al demonstrated that omission of drains was not inferior in terms of postoperative reintervention, but superior in terms of clinically relevant pancreatic fistula rate and fistula-associated complications, supporting the omission of routine prophylactic drainage after pancreatic head resections.[17] A meta-analysis including these 3 randomized trials, for a total of 711 patients, showed no statistically significant differences in 30-day mortality, overall morbidity, reintervention rates and duration of hospital stay between drains and no drains nor in occurrence of clinically relevant POPF or intraabdominal fluid collection and abscess.[18] In 2017, Van Buren et al conducted another randomized study focusing on distal pancreatectomy. They found that after distal pancreatectomy, the clinical outcomes of patients with or without intraperitoneal drainage were comparable. More

recently, our group conducted a meta-analysis including prospective and retrospective studies polling them together but also stratifying them in 2 subgroups.[16] In the subgroup meta-analysis of retrospective studies, most of the findings were in line with the subgroup analysis of the randomized trial, and overall we found no differences in mortality rate, but an increased risk of morbidity, POPF rate and readmissions for patients with drains after pancreatic resections.[19] However, we underlined that the discrepancy among the included studies, even between RCTs, that is, the participating centers (high-volume versus low-volume), the type of performed operation (pancreaticoduodenectomy or distal pancreatectomy), and the drain management (type of drain, timing of removal, etc), limited robust conclusions. As well, the authors of the Cochrane systematic review published in 2018 concluded that the current evidence about drain use after pancreatic resection is low and, accordingly, did not provide any recommendations.[2]

In our survey, although 85% of the participants still use drains and 56% believe that drains are dislocated in more than 30% of cases, the majority (25/40, 63%) declared to prefer early drain removal within 3 PODs. Early drain removal was favored as useful in reducing the risk of POPF and other complications, and, in particular, the risk of contamination and infection. Substantially, from our survey, surgeons seem to be less reluctant to the idea of removing drains within the third POD, compared with abandoning them completely. However, 10 years after the first and only prospective randomized trial[15] that demonstrated the superiority of early drain removal, its utility and safety has still been questioned in the recent literature and not yet widely implemented. Recently, early drain removal was defined as a dynamic concept, that can be employed using conditional thresholds to better identify patients at risk for clinically relevant POPF.[20] Regarding drain dislocation, what surgeons declared in our survey is in line with a recent publication, which demonstrated that drains are dislocated in approximately 30% of cases and, in 77% of them, already on the first POD.[21] Marchegiani et al postulated that drains dislocation could protect against the negative effects of maintaining drainage and lead to better postoperative outcomes. Regardless, it was surprising to record that, despite being considered not so reliable, drains are still so widely used.

In our survey, we also noted that, although the risk of contamination was a big concern between the respondents, the majority of the participants (58%) declared to prefer open passive drains, whereas 42% use active drains with close suction. In this regard, in the current literature the superiority of open passive drains has not been demonstrated yet and the type of drains seems to not significantly affect the postoperative outcome.[22–26]

Overall, the possibility to detect complications earlier and manage them better, and the resulting sense of utility and safety, although not confirmed by the mortality and morbidity rates of the meta-analyses mentioned above, is the most determinant factor for the choice of the "drain policy," supported by the 85% of respondents. In this context, the proactive use of drains for continuous irrigation of the surgical area suggested by 4 participants, although not widely applied after pancreatic resection but well known in the treatment of acute necrotizing pancreatitis,[27–29] may represent an interesting and novel approach to treat selected patients with risk factors or early signs of POPF.

In conclusion, despite a very heterogeneous management, most of the participating surgeons still advocate the use of drains in pancreatic surgery. However, given the heterogeneity of the opinions on this topic collected by our survey and present in the current literature, an important question arises: should we invest additional energy and resources for another randomized control trial comparing drains versus no-drains? Or should we yield to the fact that the individual surgeon's or institutional expertise is still determining? This is a provocative question. Certainly, further investigations are needed to achieve any progress to resolve this issue. Perhaps, overcome this impasse, more time, energy, and resources should be invested in clinical and basic research investigating the pathophysiological mechanisms underlying POPF. This recanalization of efforts might dispel false myths and provide solid evidence that may empower surgeons to either stay with their opinion or be less reluctant to modify their habits. These achievements could be crucial to determine the timing of change and find a consensus regarding the use of drains in pancreatic surgery in the near future.

Funding/Support

The authors have no funding supports to declare.

Conflict of interest/Disclosure

The authors have no conflicts of interest to declare.

Supplementary Materials

Supplementary material associated with this article can be found, in the online version, at https://doi.org/10.1016/j.surg.2021.11.023.

References

1. Bassi C, Marchegiani G, Dervenis C, et al. The 2016 update of the International Study Group (ISGPS) definition and grading of postoperative pancreatic fistula: 11 years after. *Surg*. 2017;161:584–591.
2. Zhang W, He S, Cheng Y, et al. Prophylactic abdominal drainage for pancreatic surgery. *Cochrane Database Syst Rev*. 2018;6:CD010583.
3. Jeekel J. No abdominal drainage after Whipple's procedure. *BJS*. 1992;79:182.
4. Conlon KC, Labow D, Leung D, et al. Prospective randomized clinical trial of the value of intraperitoneal drainage after pancreatic resection. *Ann Surg*. 2001;234:487–494.
5. Giovinazzo F, Butturini G, Salvia R, et al. Drain management after pancreatic resection: State of the art. *J Hepatobiliary Pancreat Sci*. 2011;18:779–784.
6. Adham M, Chopin-Laly X, Lepilliez V, et al. Pancreatic resection: Drain or no drain? *Surgery*. 2013;154:1069–1077.
7. Fisher WE, Hodges SE, Silberfein EJ, et al. Pancreatic resection without routine intraperitoneal drainage. *HPB*. 2011;13:503–510.
8. Correa-Gallego C, Brennan MF, Angelica MD, et al. Operative drainage following pancreatic resection: Analysis of 1122 patients resected over 5 years at a single institution. 2018;258:1051–1058.
9. Allen PJ. Operative drains after pancreatic resection: The Titanic is sinking. *HPB*. 2011;13:595.
10. Andrianello S, Marchegiani G, Malleo G, et al. Pancreaticojejunostomy with externalized stent vs pancreaticogastrostomy with externalized stent for patients with high-risk pancreatic anastomosis: A single-center, phase 3, randomized clinical trial. *JAMA Surg*. 2020;155:313–321.
11. Patel K, Teta A, Sukharamwala P, et al. External pancreatic duct stent reduces pancreatic fistula: A meta-analysis and systematic review. *Int J Surg*. 2014;12:827–832.
12. Motoi F, Egawa S, Rikiyama T, et al. Randomized clinical trial of external stent drainage of the pancreatic duct to reduce postoperative pancreatic fistula after pancreaticojejunostomy. *Br J Surg*. 2012;99:524–531.
13. Shrikhande SV, Sivasanker M, Vollmer CM, et al. Pancreatic anastomosis after pancreatoduodenectomy: A position statement by the International Study Group of Pancreatic Surgery (ISGPS). *Surg*. 2017;161:1221–1234.
14. Dong Z, Xu J, Wang Z, et al. *Stents for the prevention of pancreatic fistula following pancreaticoduodenectomy*. Cochrane Database Syst Rev; 2016:CD008914.
15. Bassi C, Molinari E, Malleo G, et al. Early versus late drain removal after standard pancreatic resections: Results of a prospective randomized trial. *Ann Surg*. 2010;252:207–214.
16. Van Buren G, Bloomston M, Hughes SJ, et al. A randomized prospective multicenter trial of pancreaticoduodenectomy with and without routine intraperitoneal drainage. *Ann Surg*. 2014;259:605–612.
17. Witzigmann H, Diener MK, Kißenkötter S, et al. No need for routine drainage after pancreatic head resection: The dual-center, randomized, controlled PANDRA trial (ISRCTN04937707). *Ann Surg*. 2016;264:528–535.
18. Hüttner FJ, Probst P, Knebel P, et al. Meta-analysis of prophylactic abdominal drainage in pancreatic surgery. *Br J Surg*. 2017;104:660–668.

19. Schorn S, Nitsche U, Demir IE, et al. The impact of surgically placed, intraperitoneal drainage on morbidity and mortality after pancreas resection: A systematic review and meta-analysis. *Pancreatology*. 2018;18:334–345.
20. Seykora TF, Maggino L, Malleo G, et al. Evolving the paradigm of early drain removal following pancreatoduodenectomy. *J Gastrointest Surg*. 2019;23:135–144.
21. Marchegiani G, Ramera M, Viviani E, et al. Dislocation of intra-abdominal drains after pancreatic surgery: Results of a prospective observational study. *Langenbeck's Arch Surg*. 2019;404:213–222.
22. Jiang H, Liu N, Zhang M, et al. A randomized trial on the efficacy of prophylactic active drainage in prevention of complications after pancreaticoduodenectomy. *Scand J Surg*. 2016;105:215–222.
23. Lemke M, Park L, Balaa FK, et al. Passive versus active intra-abdominal drainage following pancreaticoduodenectomy: A retrospective study using The American College of Surgeons NSQIP database. *World J Surg*. 2021;45:554–561.
24. Marchegiani G, Perri G, Pulvirenti A, et al. Non-inferiority of open passive drains compared with closed suction drains in pancreatic surgery outcomes: A prospective observational study. *Surg (United States)*. 2018;164:443–449.
25. Aumont O, Dupré A, Abjean A, et al. Does intraoperative closed-suction drainage influence the rate of pancreatic fistula after pancreaticoduodenectomy? *BMC Surg*. 2017;17:4–9.
26. Čečka F, Jon B, Skalický P, et al. Results of a randomized controlled trial comparing closed-suction drains versus passive gravity drains after pancreatic resection. *Surg*. 2018;164:1057–1063.
27. Adamenko O, Ferrari C, Schmidt J. Irrigation and passive drainage of pancreatic stump after distal pancreatectomy in high-risk patients: An innovative approach to reduce pancreatic fistula. *Langenbeck's Arch Surg*. 2020;405:1233–1241.
28. Bu X, Xu Y, Xu J, et al. Continuous irrigation around pancreatic remnant decreases pancreatic fistula-related intraabdominal complications after distal pancreatectomy. *Langenbeck's Arch Surg*. 2013;398:1083–1089.
29. Li Z, Xia C, Zhang L, et al. Peritoneal lavage for severe acute pancreatitis: A meta-analysis and systematic review. *Pancreas*. 2016;45:806–813.