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Whether T-tube biliary drainage is necessary after pancreaticoduodenectomy: a single-center retrospective study

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Abstract

Background Postoperative complications of pancreaticoduodenectomy (PD) are still a thorny problem. This study aims to verify the preventative impact of T-tube on them.

Methods The electronic medical records and follow-up data of patients who received pancreaticoduodenectomy in our center from July 2016 to June 2020 were reviewed. According to whether T tube was placed during the operation, the patients were divided into T-tube group and not-T-tube group. Propensity score matching analysis was performed to minimize selection bias.

Results A total of 330 patients underwent PD (Not-T-tube group =226, T-tube group=104). Propensity score matching resulted in 222 patients for further analysis (Not-T-tube group =134, T-tube group=88). Patients' demographics were comparable in the matched cohorts. Significantly higher incidences of clinically relevant postoperative pancreatic fistula (CR-POPF) ((14 (10.45%) VS 20 (22.73%)), *P*=0.013) were observed in the T-tube group. The total incidence of biliary anastomotic stricture (BAS) was 3.15%. The incidence was slightly lower in the T-tube group, but there was no statistically significant differentiation (6 (4.48%) VS 1 (1.14%), *P*=0.317).

Conclusions It is not feasible to prevent postoperative complications with the application of a T-tube in PD.

Keywords Pancreaticoduodenectomy, Biliary anastomotic stricture, T-tube

Introduction

Pancreaticoduodenectomy (PD) is a complicated treatment that is typically performed for malignant tumors of the pancreatic head, ampulla, and distal bile ducts. It is also possible to conduct PD on a small number of benign ampullary tumors, chronic pancreatitis, and damage to the pancreatic head duodenum [1, 2]. In current high-volume medical centers, the perioperative mortality rate has significantly fallen from more than 20% in the middle of the 20th century to 1–2%. The improvement can be attributed to the progress of surgical methods, instruments, and perioperative management [3, 4]. Even though the morbidity rate is still between 20 and 50%, numerous research have offered countermeasures for

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frequent complications such as Clinically relevant postoperative pancreatic fistula (CR-POPF), intra-abdominal infection (IAI), postpancreatectomy hemorrhage (PPH) and delayed gastric emptying (DGE) [5–9].

Biliary anastomotic stricture (BAS) is an infrequent long-term complication following PD surgery, with an incidence rate of 3–5% reported in previous studies. Patients with BAS may experience recurring episodes of cholangitis, bile duct stones, liver abscess, and other conditions that have a significant impact on their quality of life. The occurrence of BAS may be related to preoperative and postoperative percutaneous biliary drainage, postoperative bile leakage, and CR-POPF [10–12]. However, there are few studies on BAS, particularly regarding its prevention.

Previous research has demonstrated that the use of external T-tube biliary drainage has the potential to reduce the incidence of postoperative complications of PD, especially the occurrence of CR-POPF [13, 14]. Currently, in liver transplantation, it is believed that the utilization of the T-tube may decrease the occurrence of complications related to biliary anastomosis in situations when the bile duct diameter is below 7 mm [15]. However, the impact of T-tube biliary drainage on the complications follow PD remains uncertain.

Therefore, the main objective of this study is to evaluate the feasible and necessity of T-tube biliary drainage follow PD. Particular attention is paid to its preventive effect on Biliary anastomotic stricture.

Method

Study design

Patients who underwent pancreaticoduodenectomy in our center from July 2016 to June 2020 were included in this study. According to whether T-tube was placed during the operation, the patients were divided into T-tube group and not-T-tube group. The information collected by reviewing the electronic medical record system. The following baseline data was gathered: gender, age, BMI, operation time, estimated amount of blood loss (EBL), pathological diagnosis, size of mass, bile duct diameter, the length of stay after surgery (LOSAS), and postoperative complications (Bile leakage, CR-POPF, intra-abdominal infection (IAI), postpancreatectomy hemorrhage (PPH) and delayed gastric emptying (DGE). And, the primary outcome for this study is biliary anastomotic stricture (BAS). Propensity score matching (PSM) analysis was performed to minimize selection bias.

Definitions

BAS was diagnosed based on the presence of obstructive jaundice and imaging findings of anastomotic constricting or disappearance accompanied by dilation of the upper bile duct. Magnetic resonance cholangiopancreatography (MRCP) or cholangiography are the primary imaging modalities. Biliary anastomotic stricture due to tumor recurrence should also be excluded. A positive culture of the drain is diagnostic of intra-abdominal infection (IAI). Clinically relevant postoperative pancreatic fistula (CR-POPF), delayed gastric emptying (DGE) and postpancreatectomy hemorrhage (PPH) is defined according to the ISGPS definitions [9, 16, 17]. Postoperative biliary fistula was defined and graded according to the International Study Group for Liver Surgery (ISGLS).

Operative techniques

All patients underwent a standard pancreaticoduodenectomy, which included laparoscopic, robotic, and open approach [18]. Digestive reconstruction was performed with the modifed Child's method after the removal of specimen. End-to-side anastomosis of bile duct and jejunum was performed 10–15 cm from pancreaticojejunostomy. Depending on the size of the bile duct, end-to-side hepaticojejunostomy was performed using absorbable sutures with continuous suture or interrupted suture. Continuous suture of the rear wall and intermittent suture of the front wall is used frequently. When the biliary-enteric anastomosis is nearly complete, the T-tube is inserted through it. One end of the T-tube is inserted into the common hepatic duct. The other end of the T-tube enters the intestinal lumen via the biliary-enteric anastomosis and serves as mechanical support for it. T-tube often require no further fixing. The placement of the T-tube depends on the diameter of the bile duct and is usually used in patients with slender bile ducts.

Follow-up

Following discharge, patients were followed up with by phone or outpatient visit to see if they showed symptoms of obstructive jaundice (high fever, chills, jaundice, celialgia). If the symptoms listed above occur, imaging and serum bilirubin levels should be checked.

Statistical analysis

Percentages and frequencies were used for the representation of categorical variables. Verify the normality of continuous variables using the Shapiro-Wilk test. Continuous variables were reported using means and standard deviations (SD) or median and interquartile range (IQR). Continuous variables were compared by independent-samples t-tests or nonparametric Mann-Whitney U test according to whether they followed normal distribution. The Chi-square test or Fisher's exact test was used for analysis of categorical variables.

Propensity Score-matched (PSM) was used to minimize baseline differences between two groups. We utilized 1:2 nearest neighbor matching. The propensity score was estimated with logistic regression. Propensity score matching was performed based on the following variables: Age, Sex, Male, Female, BMI, History of smoking, History of Diabetes, History of Hypertension, Weight loss, Jaundice, Tumor seize, Pathology, Malignant, Benign and borderline malignant, Minimally invasive, Bile duct diameter(cm), soft pancreas. The caliper width was set to 0.2. Data were considered significant at $P<0.05$.

Result

Characteristics

A total of 330 patients underwent PD (Not-T-tube group = 226, T-tube group = 104) were included in the study. The basic information of patients is detailed in Table 1. The patients in both groups exhibited comparable baseline nutritional status and a history of underlying disorders, such as hypertension, diabetes, and smoking ($P>0.05$). The Not-T-tube group was appropriate for a greater proportion of malignant cases (169 (74.78%) vs. 52 (50%), $P<0.001$) and exhibited more preoperative jaundice (113 (50%) vs. 25 (24.04%), $P<0.001$). T-tube biliary drainage is usually used in patients with small bile duct diameters (1.2 (0.8,1.5) VS 0.8 (0.7,1), $P<0.001$). The proportion of soft pancreas in T tube group was significantly higher (49(47.6%) VS 59(26.5%), $P<0.001$). After 1:2 PSM including 222 patients ((Not-T-tube group = 134, T-tube group = 88)), there were no significant differences between two groups with regard to baseline characteristics (Table 1).

Perioperative outcome

The operation time of the T-tube group was modestly longer than that of the not-T-tube group due to the additional procedure; however, this difference was not statistically significant (368.5 (311.5,450) VS390.5, $P=0.287$). The place of a T tube during the operation did not result in an increased risk of bleeding (200(300,500) VS200(300,500), $P=0.639$). Significantly higher incidences of IAI (73 (32.3%) VS 49 (47.12%), $P=0.01$), DGE (7 (3.1%) VS 9 (8.65%), $P=0.029$) and CR-POPF (24 (10.62%) VS 23 (22.12%), $P=0.006$) were observed in the T-tube group compared to the not-T-tube group. The incidence of postoperative biliary leakage was not reduced by T-tube biliary drainage (8 (3.54%) VS 5 (4.81%), $P=0.806$). After PSM, the T-tube group had noticeably greater rates of CR-POPF (14 (10.45%) VS 20 (22.73%)), $P=0.013$. In both groups, the remaining perioperative outcomes were comparable (Table 2).

Management of T-tube

Clamp the T tube about a month after surgery. If there is no abdominal pain, fever, jaundice, or additional

Table 1 The characteristic of patients with or without T-tube

Variable	Unmatched cohort			1:2 Propensity score matching		
	Not-T-tube group (*n*=226)	T-tube group (*n*=104)	*P*	Not-T-tube group (*n*=134)	T-tube group (*n*=88)	*P*
Age	62.0 (51,69)	56.0 (49,64)	**0.002**	62 (51,69)	58.5 (53.75,66)	0.14
Sex			0.654			0.334
Male	131 (57.96%)	63 (60.58%)		75 (56%)	55(62.5%)	
Female	95 (42.04%)	41 (39.42%)		59(44%)	33(37.5%)	
BMI	21.94 (19.82,23.81)	22.23 (20.78,23.95)	0.351	22.18 (19.93,24.34)	22.18 (19.93,24.34)	0.885
History of smoking	73 (32.3%)	38 (36.54%)	0.449	33(37.5%)	49(36.6%)	0.888
History of Diabetes	49 (21.68%)	17 (16.35%)	0.26	31(23.1%)	17(19.3%)	0.499
History of Hypertension	70 (30.97%)	23 (22.12%)	0.097	41(30.6%)	23(26.1%)	0.473
Weight loss	77 (34.07%)	25 (24.04%)	0.067	42(31.3%)	24(27.3%)	0.516
Jaundice	113 (50%)	25 (24.04%)	**<0.001**	46(34.3%)	25(28.4%)	0.355
Tumor seize	3.14±1.52	3.57±2.70	0.139	3.26±1.78	3.32±1.67	0.788
Pathology			**<0.001**			0.148
Malignant	169 (74.78%)	52 (50%)		89(66.4%)	50(56.8%)	
Benign and borderline malignant	57 (25.22%)	52 (50%)		45(33.6%)	38(32.2%)	
Minimally invasive	101 (44.69%)	55 (52.88%)	0.166	58(43.3%)	43(48.9%)	0.414
Bile duct diameter (cm)	1.2 (0.8,1.5)	0.8 (0.7,1)	**<0.001**	1 (0.7,1.2)	0.8 (0.7,1.2)	0.322
soft pancreas	59(26.5%)	49(47.6%)	**<0.001**	47(35.1%)	35(39.8%)	0.478

Table 2 Comparison of perioperative and postoperative outcomes in patients with or without T-tube

	Unmatched cohort			1:2 Propensity score matching		
Variable	**Not-T-tube group (*n*=226)**	**T-tube group (*n*=104)**	***P***	**Not-T-tube group (*n*=134)**	**T-tube group (*n*=88)**	***P***
Operation time(min)	368.5 (311.5,450.0)	390.5 (325.0,480.0)	0.287	388 (325.0,457.5)	363.5(312.5,461.3)	0.598
EBL (ml)	300 (200,500)	300 (200,500)	0.639	375 (200,575)	300 (200,575)	0.282
LOSAS (days)	16 (12,21)	17 (13,26)	0.076	20 (14,28)	20 (14,28)	0.071
IBI	73 (32.3%)	49 (47.12%)	**0.01**	24 (48%)	30 (33.71%)	0.097
DGE	7 (3.1%)	9 (8.65%)	**0.029**	5 (10%)	3 (3.37%)	0.218
PPH	27 (11.95%)	14 (13.46%)	0.698	12 (13.48%)	8 (16%)	0.685
CR-POPF	24 (10.62%)	23 (22.12%)	**0.006**	14 (10.45%)	20 (22.73%)	**0.013**
Bile leakage	8 (3.54%)	5 (4.81%)	0.806	5 (3.73%)	5 (5.68%)	0.723
BAS	8 (3.54%)	1 (0.96%)	0.331	6 (4.48%)	1 (1.14%)	0.317

BAS Biliary anastomotic strictures, *EBL* estimated blood loss, *LOSAS* length of stay after surgery, *IAI* intra-abdominal infection, *DEG* delayed gastric emptying, *PPH* post pancreatectomy hemorrhage, *CR-POPF* clinically relevant postoperative pancreatic fistula

symptoms. The T tube was removed three months after surgery. The T-tube was safely removed in all patients, with no complications such as bile leakage or hemorrhage.

Biliary anastomotic stricture

Nine patients with BAS were included in the study, while 6 patients with anastomotic tumor recurrence were excluded. The total incidence of BAS was 2.72%. The incidence was slightly lower in the T-tube group, but there was no statistically significant differentiation (8 (3.54%) VS 1 (0.96%), P=0.331). After PSM, the total incidence of BAS was 3.15% (6 (4.48%) VS 1 (1.14%), P=0.317). All of the 9 patients developed cholangiolithiasis, 8 patients required surgery to remove the bile duct stones and revision of their bile duct anastomoses (Fig. 1). The median

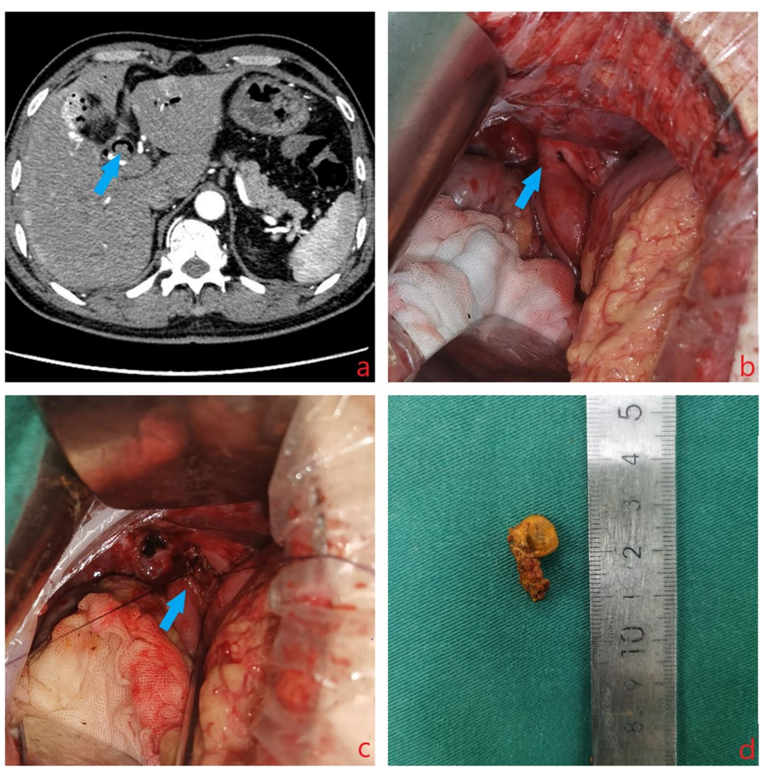

Fig. 1 **a** CT examination after PD indicates the cholangiolithiasis; **b** The arrow shows the bilioenteric anastomosis; **c** Exploration of the anastomosis , removal of intra-and extrahepatic bile duct stone, and re-anastomosis; **d** Removed bile duct stone

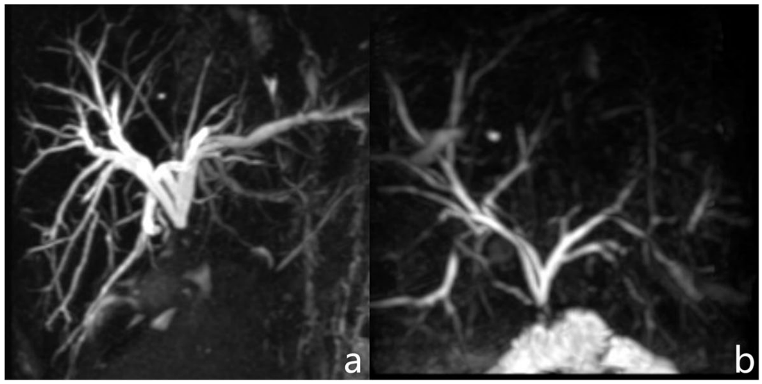

Fig. 2 **a** Intrahepatic and extrahepatic bile duct dilation due to BAS and cholangiolithiasis; **b** No bile duct dilation, 1 year after surgery

time to diagnose BAS was 38.5(14.75,48) months after surgery. The MRCP image (Fig. 2a) shows dilatation of the intrahepatic and extrahepatic bile ducts due to BAS. One year after surgery, as depicted in Fig. 2b, no evidence of choledochal dilatation.

Perioperative and postoperative outcomes in patients with malignant tumors

T-tube group have the longer LOSAS (days) (16 (12,21) VS 19.5 (13,28), $P=0.017$), as well as the higher incidence of IAI (54 (31.95%) VS 25 (48.08%), $P=0.034$) and CR-POPF (18 (10.65%) VS 13 (25%), $P=0.009$). T-tube biliary drainage did not reduce the incidence of postoperative biliary leakage (4 (2.37%) VS 3 (5.77%), $P=0.44$) and BAS (4 (2.37%) VS 0 (0%), $P=0.575$). After PSM, significantly higher incidences of CR-POPF ((8 (8.99%) VS 12 (24%)), $P=0.016$) were observed in the T-tube group. In both groups, the remaining perioperative outcomes were comparable (Table 3).

Perioperative and postoperative outcomes in patients with benign and borderline malignant tumors

For patients with benign and borderline malignant tumors, perioperative outcomes and BAS incidence were similar in the two groups (Table 4).

Discussion

Pancreaticoduodenectomy (PD), whether open or minimally invasive, can be performed safely with current developments in surgical technology and surgical instruments [19, 20]. Despite this, postoperative complications continue to occur frequently. As a result, current research should pay more attention to how to prevent the postoperative complications of PD [3, 4, 21]. External biliary drainage via T tube is thought to maintain the biliary tract and avoid bile-pancreatic fluid contact after PD. As a result, our study aims to verify the preventative impact of T-tube on PD postoperative complications. As far as we know, this is the first study to compare the difference

Table 3 Comparison of perioperative and postoperative outcomes in patients with malignant tumors

Variable	Unmatched cohort			1:2 Propensity score matching		
	Not-T-tube group (*n*=169)	T-tube group (*n*=52)	*P*	Not-T-tube group (*n*=89)	T-tube group (*n*=50)	*P*
Operation time(min)	363.5 (307.8,432.5)	384.5 (322,465)	0.533	360 (311,431)	384.5 (322.5,457.5)	0.552
EBL (ml)	300 (200,500)	300 (200,525)	0.252	400 (200,550)	300 (200,575)	0.431
LOSAS (days)	16 (12,21)	19.5 (13,28)	**0.017**	17 (12,23.5)	20 (14,28)	0.071
IBI	54 (31.95%)	25 (48.08%)	**0.034**	30 (33.71%)	24 (48%)	0.097
DGE	5 (2.96%)	5 (9.62%)	0.101	3 (3.37%)	5 (10%)	0.218
CR-POPF	18 (10.65%)	13 (25%)	**0.009**	8 (8.99%)	12 (24%)	**0.016**
PPH	20 (11.83%)	8 (15.38%)	0.501	12 (13.48%)	8 (16%)	0.685
Bile leakage	4 (2.37%)	3 (5.77%)	0.44	2 (2.25%)	3 (6%)	0.506
BAS	4 (2.37%)	0 (0%)	0.575	2 (2.25%)	0 (0%)	0.536

BAS Biliary anastomotic strictures, *EBL* estimated blood loss, *LOSAS* length of stay after surgery, *IAI* intra-abdominal infection, *DEG* delayed gastric emptying, *PPH* postpancreatectomy hemorrhage, *CR-POPF* clinically relevant postoperative pancreatic fistula

Table 4 Comparison of perioperative and postoperative outcomes in patients with benign and borderline malignant tumors

	Unmatched cohort			**1:2 Propensity score matching**		
Variable	**Not-T-tube group (*n*=57)**	**T-tube group (*n*=52)**	***p***	**Not-T-tube group (*n*=45)**	**T-tube group (*n*=38)**	***p***
Operation time(min)	379(321.75,497.75)	393 (330.75,490.5)	0.807	383.0(321.5,512.0)	390.5 (329.8,457.5)	0.914
EBL (ml)	300 (100,700)	300 (150,500)	0.802	300 (200,650)	250 (150,525)	0.643
LOSAS (days)	14 (12,25)	16 (12,21.25)	0.697	14 (11.75,25.25)	16 (11,21)	0.794
IBI	19 (33.33%)	24 (46.15%)	0.171	18 (40%)	16 (42.11%)	0.846
DGE	2 (3.51%)	4 (7.69%)	0.592	2 (4.44%)	1 (2.63%)	1.000
CR-POPF	6 (10.53%)	10 (19.23%)	0.200	6 (13.33%)	8 (21.05%)	0.349
PPH	7 (12.28%)	6 (11.54%)	0.905	6 (13.33%)	5 (13.16%)	0.981
Bile leakage	4 (7.02%)	2 (3.85%)	0.761	3 (6.67%)	2 (5.26%)	1.000
BAS	4 (7.02%)	1 (1.92%)	0.417	4 (8.89%)	1 (2.63%)	0.465

BAS Biliary anastomotic strictures, *EBL* estimated blood loss, *LOSAS* length of stay after surgery, *IAI* intra-abdominal infection, *DEG* delayed gastric emptying, *PPH* postpancreatectomy hemorrhage, *CR-POPF* clinically relevant postoperative pancreatic fistula

in postoperative outcome of PD with or without a T tube in a large number of cases.

Previous studies have shown that the incidence of BAS is ranges from 2.4–4.9% [10, 12, 22]. Our research revealed a 2.7% incidence of BAS overall. Because the treatment and prognosis differ significantly between tumor recurrence and benign BAS, we excluded 6 patients who were considered for tumor recurrence. In this study, the incidence of BAS in the T-tube group was slightly lower than that in the non-T-tube group, but there was no significant difference. Similar results were obtained when patients with benign and malignant tumors were discussed separately. Initially, we hoped that mechanical support to the biliary tract of the T tube would prevent BAS. This research indicates that the support function of the T-tube does not provide a significant preventive effect for the BAS.

Previous studies have suggested that external T-duct biliary drainage could reduce the incidence of CR-POPF by reducing the pressure of bile duct and avoiding the activation of pancreatic fluid [13, 14]. In the study of Tabatabaee, S., et al., the incidence of CR-POPF was lower in the T-tube group, but there were only 4 cases of standard PD. Cianci, P., et al. suggested that T tube could reduce the occurrence of postoperative complications after PD, but no comparison was made with the not-T tube group. Interestingly, the incidence of CR-POPF in our study was significantly higher in the T-tube group. And similar results were found in patients with malignant tumors. However, in benign and borderline malignant cases, the incidence of CR-POPF was comparable in both groups. Previous studies suggested soft pancreatic texture associated with the development of CR-POPF [23]. T-tubes are usually placed in patients whose biliary ducts are not dilated. The pancreas in these patients is usually soft in texture. However, after PSM, the proportion of soft pancreas in the two groups was similar, and the incidence of CR-POPF was still significantly higher in the T-tube group. To sum up, it is undeniable that T tube biliary drainage is not an effective method for preventing CR-POPF following PD.

DEG can prolong hospital stay and significantly impair patients' quality of life. Previous studies have shown that the occurrence of DEG is related to postoperative complications such as CR-POPF [24–26]. Therefore, the considerably elevated incidence of CR-POPF in the T-tube group might contribute to an increased occurrence of DEG. The incidence of IAI in the T-tube group was significantly higher than that in the not-T-tube group. The relationship between IAI and CR-POPF is intricate, making it challenging to ascertain who is the source and who is the result. Moreover, it was disappointing to note that the length of stay after surgery in the T-tube group was significantly longer in patients with malignant tumors. Following PSM, the perioperative results were similar in both groups, with no benefit to patients in the T-tube group. The findings show that the T tube is unsuccessful in reducing common complications associated with PD.

By comparing the perioperative outcomes and long-term follow-up results of the T-tube group and the not-T-tube group. T-tube biliary drainage does not reduce the incidence of postoperative complications or the development of BAS, according to our results. Additionally, the T-tube usually needs to be removed three months following the surgery. This may possibly impair the quality of life for the patient. What's more, the placement of the T tube lengthens the operation duration and complicates the surgical process. Therefore, we advise with caution that the use of T tube in PD to prevent postoperative complications is not feasible.

The limitations of single-center retrospective studies are unavoidable. For patients with significant dilation of the common bile duct, the placing of a T tube was not taken into account. Therefore, the placement of T-tubes is not completely random. This may lead to some selection bias. So, we applied PSM to reduce these biases.

Conclusion

T-tube biliary drainage after PD does not reduce the incidence of postoperative complications or the development of BAS. Therefore, it is not feasible to prevent postoperative complications with the application of a T-tube in PD.

Abbreviations

PD	Pancreaticoduodenectomy
CR-POPF	Clinically relevant postoperative pancreatic fistula
IAI	Intra-abdominal infection
PPH	Postpancreatectomy hemorrhage
DEG	Delayed gastric emptying
BAS	Biliary anastomotic stricture
LOSAS	Length of stay after surgery
MRCP	Magnetic resonance cholangiopancreatography
ISGLS	International Study Group for Liver Surgery
SD	Standard deviations
IQR	Interquartile range
PSM	Propensity score matching

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Authors' contributions
(I) Study conception and design: Fengchun Lu and Heguang Huang; (II) Acquisitionof data: Xinbin Zhuo, Ronggui Lin, Xianchao Lin; (III) Analysis and interpretation of data: Congfei Wang, Yuanyuan Yang and Haizong Fang; (IV) Drafting of manuscript: Xin Luo and Ronggui Lin; (V) Critical revision of manuscript: Xin Luo and Xinbin Zhuo; (VI) Final approval of manuscript: all authors. All authors reviewed the manuscript.

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Availability of data and materials
The datasets used during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
The study was conducted according to the guidelines of the Declaration of Helsinki. The need for approval was waived by the Ethical Committee of Fujian Medical University Union Hospital for this retrospective study. Informed consent was obtained from all subjects involved in the study.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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