

Two-layer duct-to-mucosa pancreaticojejunostomy with a half purse-string suture: A novel anastomosis technique for soft pancreas

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Research

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Abstract

Background: Pancreaticoduodenectomy (PD) is a routine method in pancreatic surgery. To date, postoperative pancreatic fistula (POPF) remains the most common complication and is also the major cause to death after pancreaticoduodenectomy. In order to reduce the incidence of POPF, we established a new anastomosis technique where we use a half purse-string suture on the basis of two-layer duct-to-mucosa pancreaticojejunostomy (PJ) technique and also assessed the effectiveness and safety of this approach in this study.

Methods: To evaluate this new approach, 80 patients who received the new PJ technique were included in this study during 2017–2018. Meanwhile, 195 patients who underwent traditional duct-to-mucosa PJ were collected. We also introduced this new surgical approach in detail and analyzed various risk factors for postoperative complications to verify its safety and advantages.

Results: First of all, there were no significant differences in patients' preoperative characteristics. Besides, patients in the new PJ group received a less operative time (175.2 ± 45.8 vs. 161.3 ± 41.0 , $p=0.022$) while no differences were found in blood loss, length of hospital stay and cost. The incidence of POPF in the new PJ group was 19%, which was much lower than those in the traditional PJ group (36%) ($p=0.007$). More importantly, a much lower incidence of grades B POPF (14% vs. 4%, $p=0.026$) was found in the new technology group, which would clinically benefit patients a lot. Univariate and multivariate regression analysis also verified that this new PJ procedure was effective to improve postoperative POPF.

Conclusions: Results demonstrate that this new technique is easy accomplished, safe and effective compared to traditional approach, which showed satisfactory outcomes especially at resulting in a lower POPF incidence.

Introduction

Pancreaticoduodenectomy(PD) is a widely used procedure for malignant and benign tumors of the pancreatic head and the ampullar region (1). Standard PD is a complex procedure including anastomosis of multiple organs and reconstruction of digestive system. Although it is reported quite safe and the mortality related to PD has decreased to approximately 2% in some big centers(2, 3), the overall operative morbidity after PD has remained between 30% and 50%, as reported (4, 5). Postoperative pancreatic fistula (POPF) is considered the most common complication associated with patients morbidity and mortality, which results from leakage of secretions at the anastomotic stoma with a high rates between 10% and 28% (6). Studies demonstrate that patients with POPF have a worse overall survival, as well as higher complications, longer hospital stay (7, 8). Well recognized risk factors related to POPF include gender, diabetes, BMI, pancreaticojejunal anastomosis technique, the diameter of the pancreaticduct and pancreatic texture (9). As pancreaticojejunostomy(PJ) is the most crucial step, numerous surgical groups have investigated several methods to build a stable PJ for reducing the incidence of POPF(2, 5, 10), including pancreaticogastrostomy(11), duct-to-mucosa anastomosis(12), pancreatic duct occlusion, the

use of biologic adhesive (13-15), Chen's U-stitch approach(16) and end-to-side suspender PJ(17). Here, in our institution, we studied a novel anastomosis technique where we use the half purse-string suture on the basis of two-layer duct-to-mucosa pancreaticojejunostomy technique, which effectively invaginated the pancreas into the jejunum in addition to allowing a duct-to-mucosa anastomosis.

Materials And Methods

Patients

From January 1, 2017 and October 31, 2018, patients with malignant disease, including carcinoma of the pancreas and the duodenum were collected. The half purse-string suture on the basis of two-layer duct-to-mucosa pancreaticojejunostomy technique was performed in 80 patients f (T-PJ group), while other 195 patients received traditional end-to-side invagination PJ technology (C-PJ group). Every informed consent was signed before surgery. Patients are informed that their data will be used in retrospective clinical studies, however, the type of clinical studies are secretive to patients. Besides, we will discuss every patient's condition the day before the surgery and decide whether this new PJ is necessary according to the patient's image information (tumor size and location), other preoperative demographics and laboratory data. On the other hand, surgeons evaluated the texture of the pancreas during the surgery again. According to the experience in our center, those patients with pancreatic duct dilatation and pancreatic fibrosis are less likely to pancreatic fistula. As a result, this new method is not required for those patients when we are not clear about its safety and effectiveness. Postoperative octreotide was used in all patients. Besides, in order to better analyze the safety of this new PJ technique, the International Study Group (ISGPS) definition and grading of postoperative pancreatic fistula were adopted in this study. Level of amylase in drainage fluid via an operatively placed drain was measured every two days after surgery day 3. All the patients were included consecutively. This study is being reported in line with the STROCCS 2019 guideline and approved by Shanghai Changhai Hospital Ethics Committee.

Operative Technique

In the distal pancreas, a 1.0-1.5cm long stump of pancreas was freed. The pancreaticojejunal anastomosis was covered by the jejunal wall and could be securely fixed well within the pouch formed from the intestinal wall with our half purse-string suture invagination technique. The half purse-string suture technique made the pancreaticojejunal anastomosis successful invagination without suturing the pancreatic parenchyma. This procedure was performed as follows. The pancreatic parenchyma was clearly transected with electrocautery, and then we used a scalpel transect main pancreatic duct when approaching pancreatic duct position. Hemostasis procedures included suture ligatures or electrocautery. The cutting end of the pancreatic stump was isolated for a distance of 1.0-1.5cm. After identifying the main pancreatic duct, we inserted a silicone tube into the main duct to avoid pancreatic duct occlusion and also fixed the tube with suturing thread. The jejunum was positioned in the lesser sac through a rent in the transverse mesocolon. Make a half purse-string suture near the posterior mesenteric border of the

jejunum with 2-0 silk suture. The length of the half purse-string suture should be a little more than the width of the pancreatic stump (picture 1-a). We tightly laced the silk thread around pancreatic stump at about 1.0 cm from the cut margin. Thus, jejunum was then wrapped the posterior of the pancreatic stump (picture 1-b). Then we made the two-layer end-to-side duct-to-mucosal pancreatico-jejunal anastomosis. The first posterior layer was sutured between the pancreatic parenchyma of the stump and the seromuscular layer of the jejunum using interrupted silk thread. Then we made a small hole on the antimesenteric border of the jejunum which was opposite to the pancreatic duct. Next, the second layer was performed between the pancreatic duct and all layers of the jejunal wall also by interrupted silk thread sutures (picture 1-c). The silicon tube placed into the main pancreatic duct before was then inserted in jejunal lumen after the posterior side of the second layer was completed. The anterior two layers of the pancreatico-jejunal anastomosis were anastomosed in the reverse order and in the same manner (picture 1-d). The last layer was stitched together with interrupted silk thread sutures between the seromuscular layer of the anterior border of the jejunum and the silk thread used for half purse-string suture (picture 1-e,f).

Statistical analysis

SPSS 21.0 was used for the statistical analysis in this study. Continuous data were expressed as mean \pm standard deviation (SD). Normally distributed variables were compared using the two independent-samples Student's t test. Categorical data were compared using the Chi-square test or Fisher's exact test. Univariate and multivariate analysis were performed by logistic regression. A p value less than 0.05 was considered statistically significant.

Results

From January 1, 2017 and October 31, 2018, 80 consecutive cases were performed with this new technique. We also performed classical duct-to-mucosa in other 195 patients in our department. The preliminary results were quite encouraging in half purse-string suture group compared to classical duct-to-mucosa group. As detailed in Table 1, no statistical significances in clinical characteristics of patients between the two groups were found, including the gender, age, BMI, diabetes, total bilirubin, CA-199 and tumor size. Besides, the average blood loss during the operations was 330.9 ± 251.3 min vs. 405.3 ± 438.7 min, $p=0.167$, while T-PJ group received a less operative time (161.3 ± 41.0 min vs. 175.2 ± 45.8 min, $p=0.002$). Referring to postoperative outcomes and complications in patients, mean hospital stay of patients with the new technology was 14.8 days and mean cost was 72397.9 RMB. None of the cases developed single or multiple organ dysfunctions and no hemorrhage or abdominal abscess was observed. Besides, in order to analyze the surgical outcomes of this technique, POPF was defined according to the International Study Group (ISGPS) definition and grading of postoperative pancreatic fistula. POPF occurred in 15 patients (19%) who received the new PJ technique, which was significantly lower than those in C-PJ group (35%) ($p=0.007$). What's more, patients in T-PJ group received a much lower incidence of "clinically relevant" fistulas (grades B 4% vs. 14%, $p=0.026$), which would benefit patients a lot. There were also no differences in other complications including delayed gastric emptying

and infection (Table 1). What's more, we then performed univariate logistic regression model to analyze clinical risk factors for POPF. Results verified that soft pancreatic texture ($p=0.002$) and T-PJ producer ($p=0.008$) were significant risk factors for the incidence of POPF (Table 2). Further multivariate analysis of these two factors showed that soft texture and surgical procedure were the significant risk factors of POPF (Table 2). Taken together, all these results confirmed that this new PJ technique decreases POPF importantly.

Discussion

With advances in technology, PD is reported to be safer than before. Although the postoperative mortality rate of patients after pancreatic surgery has decreased, the incidence of postoperative POPF is still high at big volume centers (4). POPF remains the most common and serious clinical complication after pancreaticoduodenectomy, which may worsen both early and long-term outcomes for patients. Among those definite risk factors for POPF (include patient factor, operation factor and pancreas factor (18, 19)), soft pancreatic texture may be the most important factor. Besides, the degree of pancreatic fibrosis is another important factor (20). One of the reasons is that the shear forces applied during fixing the tube with suturing thread will lacerates the gland and a pancreatic leakage may easily occur from the area of the suture placement. Therefore, a reliable way to better place the tube into the main pancreatic duct and carefully fix this structure is needed (21). Hence many surgical procedures have been used in the management of the pancreatic remnant including pancreaticojejunostomy, pancreaticogastrostomy and other new PJ technology (16, 17). Besides, recent studies found that the smear positivity of drainage fluid on POD 3 was one of the independent risk factors for POPF (22, 23).

In our study, we introduced a new technique: the half purse-string suture technique, which was detailed introduced in the article. This new technique showed favorable results in our 80 patients. No significant differences were found in demographics outcomes. Besides, compared to traditional PJ, patients with this half purse-string suture technique received a less operative time ($161.3\pm 41.0\text{min}$ vs. $175.2\pm 45.8\text{min}$, $p=0.022$). Furthermore, only 19% patients developed POPF (36% in control group, $p=0.007$). Among these patients, rate of grade B-type POPF sharply decreased (4% vs. 14%, $p=0.026$). Further regression analysis confirmed that T-PJ technology could reduce the incidence of POPF. Therefore, this new surgical technique is safe and effective.

Our half purse-string suture technique has several advantages by making the pancreaticojejunal anastomosis successful invagination without suturing the pancreatic parenchyma. With this invagination technique, the pancreaticojejunal anastomosis is covered by the jejunal wall and can be securely fixed well within the pouch formed from the intestinal wall. It is a good method to protect the pancreaticojejunostomy. We can avoid parenchymal tearing at the outermost layer of invaginating sutures with no suture in the pancreas. The possibility of pancreatic juice leakage has been greatly reduced with this technique for soft pancreas. The possibility of hemostasis of the cut end of the pancreatic remnant has also been reduced with this technique. It is necessary to insert a suitable silicon

tube into the main pancreatic duct in this technique. We believe that this will help to avoid occlusion of the main pancreatic duct.

One limitation of our study is that this new T-PJ is carried out by surgeons from one department. Surgeon's experience is reported to be a significant factor for incidence of POPF (9, 18). Besides, a multicenter randomized control trial is needed to further evaluate the safety and effectiveness of this technology. We hope that this technique will be accepted more widely in the near future. Besides, [laparoscopic and robot pancreaticoduodenectomy](#) are widely used worldwide (24-26), which provides more challenges for surgeons.

Conclusions

Results demonstrated that our half purse-string suture technique is safe and easy to perform. More important is that this technique could effectively reduce the incidence of POPF.

List Of Abbreviations

Pancreaticoduodenectomy (PD), pancreaticojejunostomy (PJ), postoperative pancreatic fistula (POPF), two-layer duct-to-mucosa pancreaticojejunostomy (T-PJ), classical pancreaticojejunostomy (C-PJ).

Declarations

Ethical approval and consent to participate

The study was approved by Shanghai Changhai Hospital Ethics Committee. Written informed consent was obtained from all participants.

Consent for publication

Not applicable

Availability of data and materials

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

Competing interest

The authors declare that they have no competing interests.

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Authors' contributions

Yao Meng, Yabo Jiang, Wei Jing: Data curation, Formal analysis, Writing - original draft.

Yabo Jiang, Kailian Zheng, Peng Cheng, Yijie Zhang: Methodology, Writing - original draft.

Gang Jin, Tianlin He: Conceptualization, Funding acquisition, Supervision, Writing - review & editing.

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References

1. Nassour I, Choti MA. Pancreatic Operations. *Jama*. 2016;316(18):1932.
2. Wolfgang CL, Pawlik TM. Pancreaticoduodenectomy: time to change our approach? *The Lancet Oncology*. 2013;14(7):573-5.
3. Yuan F, Essaji Y, Belley-Cote EP, Gafni A, Latchupatula L, Ruo L, et al. Postoperative complications in elderly patients following pancreaticoduodenectomy lead to increased postoperative mortality and costs. A retrospective cohort study. *International journal of surgery (London, England)*. 2018;60:204-9.
4. Winter JM, Cameron JL, Campbell KA, Arnold MA, Chang DC, Coleman J, et al. 1423 pancreaticoduodenectomies for pancreatic cancer: A single-institution experience. *Journal of gastrointestinal surgery : official journal of the Society for Surgery of the Alimentary Tract*. 2006;10(9):1199-210; discussion 210-1.
5. Ravi M, Shamir C, Patrick H, Vijay N. Reduced complication rate after modified binding purse-string-mattress sutures pancreatogastrostomy versus duct-to-mucosa pancreaticojejunostomy. *The surgeon : journal of the Royal Colleges of Surgeons of Edinburgh and Ireland*. 2014;12(2):117.
6. Pedrazzoli S. Pancreatoduodenectomy (PD) and postoperative pancreatic fistula (POPF): A systematic review and analysis of the POPF-related mortality rate in 60,739 patients retrieved from the English literature published between 1990 and 2015. *Medicine*. 2017;96(19):e6858.
7. Butturini G, Daskalaki D, Molinari E, Scopelliti F, Casarotto A, Bassi C. Pancreatic fistula: definition and current problems. *Journal of hepato-biliary-pancreatic surgery*. 2008;15(3):247-51.
8. Vin Y, Sima CS, Getrajdman GI, Brown KT, Covey A, Brennan MF, et al. Management and outcomes of postpancreatectomy fistula, leak, and abscess: results of 908 patients resected at a single institution between 2000 and 2005. *Journal of the American College of Surgeons*. 2008;207(4):490-8.
9. Hu BY, Wan T, Zhang WZ, Dong JH. Risk factors for postoperative pancreatic fistula: Analysis of 539 successive cases of pancreaticoduodenectomy. *World journal of gastroenterology*. 2016;22(34):7797-805.

10. Topal B, Aerts R, Hendrickx T, Fieuws S, Penninckx F. Determinants of complications in pancreaticoduodenectomy. *European journal of surgical oncology : the journal of the European Society of Surgical Oncology and the British Association of Surgical Oncology*. 2007;33(4):488-92.
11. Ke S, Ding XM, Gao J, Zhao AM, Deng GY, Ma RL, et al. A prospective, randomized trial of Roux-en-Y reconstruction with isolated pancreatic drainage versus conventional loop reconstruction after pancreaticoduodenectomy. *Surgery*. 2013;153(6):743-52.
12. Ibrahim S, Tay KH, Launois B, Ta NC. Triple-layer duct-to-mucosa pancreaticojejunostomy after pancreaticoduodenectomy. *Digestive surgery*. 2006;23(5-6):296-302.
13. Govindarajan A, Tan JC, Baxter NN, Coburn NG, Law CH. Variations in surgical treatment and outcomes of patients with pancreatic cancer: a population-based study. *Annals of surgical oncology*. 2008;15(1):175-85.
14. Hines OJ, Reber HA. Technique of pancreaticojejunostomy reconstruction after pancreaticoduodenectomy. *Journal of hepato-biliary-pancreatic surgery*. 2006;13(3):185-9.
15. Katsaragakis S, Antonakis P, Konstadoulakis MM, Androulakis G. Reconstruction of the pancreatic duct after pancreaticoduodenectomy: a modification of the Whipple procedure. *Journal of surgical oncology*. 2001;77(1):26-9; discussion 30.
16. Chen XP, Huang ZY, Lau JW, Zhang BX, Zhang ZW, Chen YF, et al. Chen's U-suture technique for end-to-end invaginated pancreaticojejunostomy following pancreaticoduodenectomy. *Annals of surgical oncology*. 2014;21(13):4336-41.
17. Li B, Xu C, Qiu ZQ, Liu C, Yi B, Luo XJ, et al. An end-to-side suspender pancreaticojejunostomy: A new invagination pancreaticojejunostomy. *Hepatobiliary & pancreatic diseases international : HBPD INT*. 2018;17(2):163-8.
18. Gill G, Morita S, Kitanosono T, Fang A, Lee D, Waldman D. Incidence and complications of accidental cannulation of retroperitoneal veins during venography for inferior vena cava filter placement. *Annals of vascular surgery*. 2013;27(6):767-73.
19. Machado NO. Pancreatic fistula after pancreatectomy: definitions, risk factors, preventive measures, and management-review. *International journal of surgical oncology*. 2012;2012:602478.
20. Deng Y, Zhao B, Yang M, Li C, Zhang L. Association Between the Incidence of Pancreatic Fistula After Pancreaticoduodenectomy and the Degree of Pancreatic Fibrosis. *Journal of gastrointestinal surgery : official journal of the Society for Surgery of the Alimentary Tract*. 2018;22(3):438-43.
21. Bo ZY, Qiu YH, Shen NJ, Yang FC, Duan AQ, Zhu B, et al. [Applicational value of modified pancreaticojejunostomy and risk factors of pancreatic fistula following pancreaticoduodenectomy]. *Zhonghua wai ke za zhi [Chinese journal of surgery]*. 2019;57(6):434-9.
22. Morimoto M, Honjo S, Sakamoto T, Yagyu T, Uchinaka E, Amisaki M, et al. Bacterial smear test of drainage fluid after pancreaticoduodenectomy can predict postoperative pancreatic fistula. *Pancreatology : official journal of the International Association of Pancreatology (IAP) [et al]*. 2019;19(2):274-9.

23. Loos M, Strobel O, Legominski M, Dietrich M, Hinz U, Brenner T, et al. Postoperative pancreatic fistula: Microbial growth determines outcome. *Surgery*. 2018;164(6):1185-90.
24. Nassour I, Wang SC, Porembka MR, Yopp AC, Choti MA, Augustine MM, et al. Robotic Versus Laparoscopic Pancreaticoduodenectomy: a NSQIP Analysis. *Journal of gastrointestinal surgery : official journal of the Society for Surgery of the Alimentary Tract*. 2017;21(11):1784-92.
25. Liu R, Zhang T, Zhao ZM, Tan XL, Zhao GD, Zhang X, et al. The surgical outcomes of robot-assisted laparoscopic pancreaticoduodenectomy versus laparoscopic pancreaticoduodenectomy for periampullary neoplasms: a comparative study of a single center. *Surgical endoscopy*. 2017;31(6):2380-6.
26. Zhang Y, Hong D, Zhang C, Hu Z. Total laparoscopic versus robot-assisted laparoscopic pancreaticoduodenectomy. *Bioscience trends*. 2018;12(5):484-90.

Tables

Table 1. Demographics, operative characteristics and postoperative outcomes in patients.

Variables	C-PJ(n=195)	T-PJ(n=80)	P value
Sex(male/female)	128/67	47/33	0.920
Age(years)	60.3±10.8	60.5±11.0	0.880
BMI(kg/m ²)	22.5±2.8	22.4±3.6	0.854
Diabetes(n,%)	26(13%)	9(11%)	0.638
TB(umol/L)	76.0±101.8	85.3±105.6	0.559
CA-199(u/ml)	277.3±415.7	280.6±439.8	0.960
Tumor size(cm)	3.2±1.7	2.8±1.4	0.054
Operative time(min)	175.2±45.8	161.3±41.0	0.022*
Blood loss(ml)	405.3±438.7	330.9±251.3	0.167
Pancreatic texture(soft/hard)	103/92	47/33	0.370
POPF	69(36%)	15(19%)	0.007*
A(n, %)	39(20%)	12(15%)	0.333
B (n, %)	27(14%)	3(4%)	0.026*
C (n, %)	3(2%)	0	1
Delayed gastric emptying	6	3	1
Infection	56(29%)	15(19%)	0.086
Reoperation (n,%)	2	0	1
Mortality (n, %)	1	0	1
Length of hospital stay(days)	15.6±9.0	14.8±8.9	0.502
Cost(RMB)	70523.2	72397.9	0.659

Table 2. Univariate and multivariate analysis of factors associated with POPF.

Variables	Univariate analysis		Multivariate analysis	
	OR (95% CI)	P value	OR (95% CI)	P value
Sex (male/female)	0.768(0.433-1.364)	0.368		
Age (years) ≥ 60 vs <60	1.174(0.676-2.039)	0.568		
Diabetes (Yes/No)	0.546(0.223-1.335)	0.185		
BMI (kg/m^2) ≥ 25 vs ≤ 25	0.697(0.333-1.460)	0.338		
Urea (umol/L) (≥ 40 vs <40)	1.217(0.699-2.121)	0.488		
Foot size (cm) (≥ 3 vs <3)	1.056(0.581-1.918)	0.859		
Food loss (ml) (≥ 1000 vs <1000)	2.172 (0.744-6.337)	0.156		
Creatic texture (soft vs hard)	2.532(1.439-4.456)	0.001	2.576(1.481-4.482)	0.001
Surgical procedure (C-PJ vs T-PJ)	2.571(1.326-4.988)	0.005	2.594(1.358-4.958)	0.004

Figures

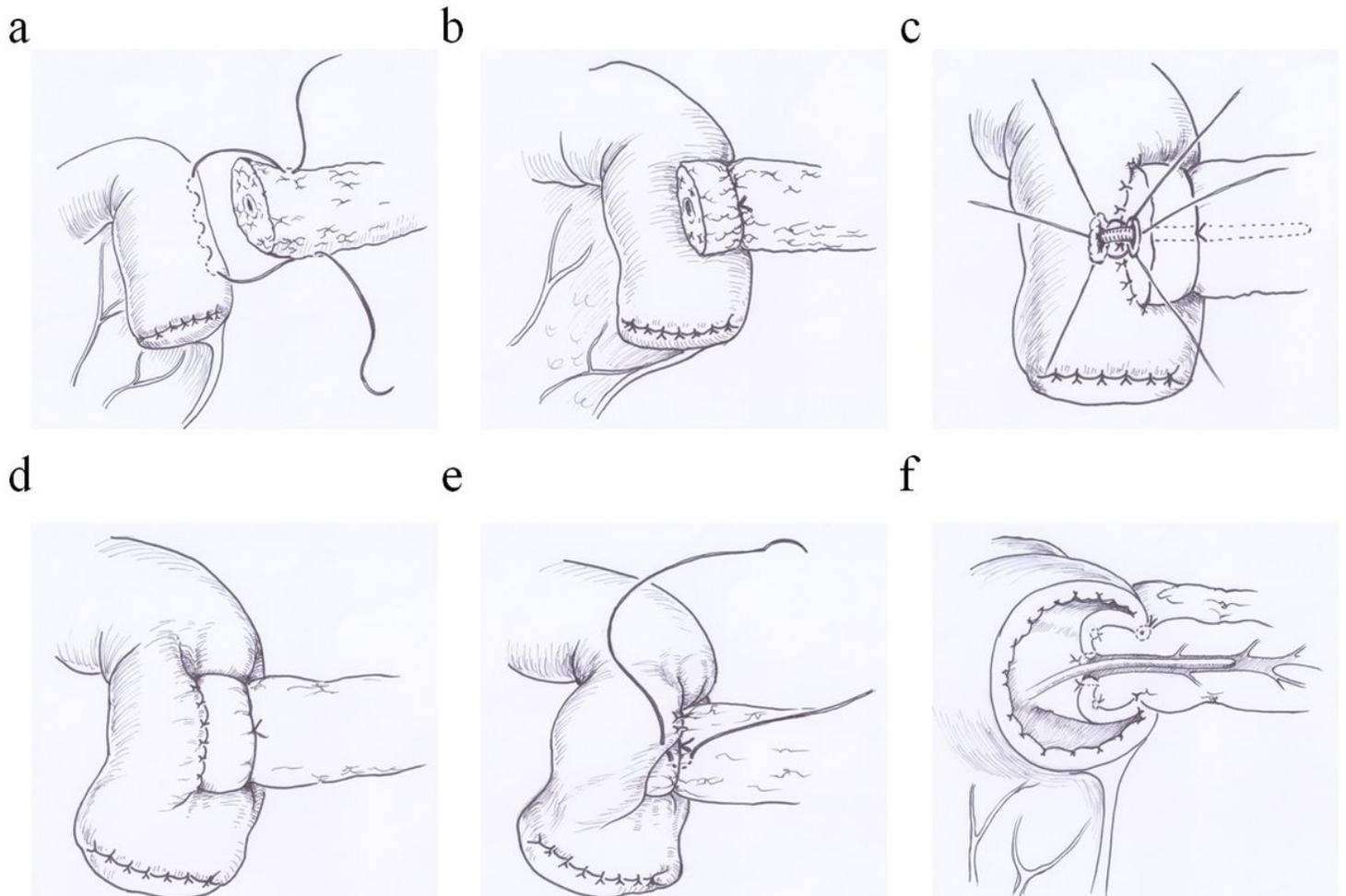


Figure 1

Two-layer duct-to-mucosa pancreaticojejunostomy with a half purse-string suture. picture a: Make a half purse-string suture near the posterior mesenteric border of the jejunum with 2-0 silk suture. picture b: The silk thread was tightly laced around pancreatic stump at about 1.0 cm from the cut margin. picture c: Make the two-layer end-to-side duct-to-mucosal pancreatico-jejunal anastomosis. The posterior two layers were constructed. picture d: Make the two-layer end-to-side duct-to-mucosal pancreatico-jejunal anastomosis. The anterior two layers were constructed. picture e: The last anterior layer was constructed by use of interrupted silk thread sutures between the seromuscular layer of the anterior border of the jejunum and the silk thread used for half purse-string suture. picture f: View of completed pancreatico-jejunal anastomosis.