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Clinical Study on Suspension Pancreatic-Duct-Jejunum End-to-Side Continuous Suture Anastomosis in Pancreaticoduodenectomy

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Objective To study the influence of Suspension Pancreatic-Duct-Jejunum End-to-Side Continuous Suture Anastomosis (SPDJCS) on the incidence of pancreatic fistula after pancreaticoduodenectomy, and to analyze its applicability, safety, and efficacies.

Methods A prospective controlled trial was conducted with 165 cases receiving pancreaticoduodenectomy in the Department of Hepatopancreatobiliary Surgery from January 2010 to May 2012. The patients were divided into Group A (end-to-end/end-to-side invaginated anastomosis, $n=52$), Group B (end-to-side mucosal anastomosis, $n=48$), and Group C (SPDJCS, $n=65$). The preoperative data, intraoperative data, and operative outcomes (incidence of pancreatic fistula, operation time, intraoperative blood loss, peritoneal drainage, peritoneal hemorrhage, peritoneal abscess, delayed gastric emptying, pulmonary infection, postoperative infection, blood transfusion, and perioperative mortality) were compared among the 3 groups.

Results The total incidence of pancreatic fistula was 13.9% (23/165) in all the 165 patients. The incidence in Group A and Group B was 23.1% (12/52) and 18.8% (9/48), both higher than that in Group C [3.1% (2/65), both $P<0.05$]. Group C showed significantly better outcomes than group A and B in terms of the operation time (5.5 ± 1.2 hours vs. 6.1 ± 1.1 hours, 5.5 ± 1.2 hours vs. 6.3 ± 1.5 hours), volume of blood loss (412.0 ± 205.0 mL vs. 525.0 ± 217.0 mL, 412.0 ± 205.0 mL vs. 514.0 ± 217.0 mL), and postoperative drainage amount of plasma tubes (175.0 ± 65.0 mL vs. 275.0 ± 80.0 mL, 175.0 ± 65.0 mL vs. 255.0 ± 75.0 mL) (all $P<0.05$), while Group A and Group B displayed no difference in these aspects ($P>0.05$). As complications other than pancreatic fistula were concerned, the three groups were not different from each other ($P>0.05$).

Conclusions SPDJCS may have the effect of reducing the incidence of pancreatic fistula after pancreaticoduodenectomy. It could be safe, practical and convenient technique of anastomosis for pancreaticojejunostomy.

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PANCREATICOJUNOECTOMY (PD) was a classical operation performed to treat cancerous tumours in the head of the pancreas and periampullary cancer. However, due to its long operation time, combined resection of several vitals (including stomach, duodenum, upper jejunum, and pancreatic head), and reconstruction of gastrointestinal tract, PD is associated with several postoperative complications, among which one of the severest is pancreatic fistula.¹⁻⁴ Many factors affect the incidence of pancreatic fistula, such as the skills of the surgeon and the type of pancreaticojejunostomy, in which the only controllable factor is the type of anastomosis.⁴⁻⁸ Based on clinical practice, the surgical team of Department of Hepatopancreatobiliary Surgery of Sichuan Provincial People's Hospital has developed a new type of pancreaticojejunostomy that we named "suspension pancreatic duct-jejunum end-to-side continuous suture anastomosis (SPDJCS)", achieving satisfactory clinical outcome. To evaluate the efficacy of this type of anastomosis in preventing post-PD pancreatic fistula, as well as its practicality and safety, a prospective non-randomized controlled study was conducted based on the clinical data of PD cases from January 2010 to May 2012.

PATIENTS AND METHODS

Patients

From January 2010 to May 2012, 165 cases treated with PD were divided into 3 groups (group A, B, and C) according to the difference in anastomosis types. The patients were fully informed of the study and had signed informed consent forms before the grouping. The surgeons for each group were the same throughout this study.

Group A (end-to-end /end-to-side invaginated anastomosis) included 52 cases, with 36 males and 16 females, aged 51.2 ± 17.2 years (31-73 years); 45 cases with icterus and 21 cases with hypoproteinemia; 3 cases of benign lesions in the head of the pancreas, including 1 case of cystadenoma and 2 cases of mass-type chronic pancreatitis (MTCP).

Group B (end-to-side mucosal anastomosis) included 48 cases, with 34 males and 14 females, aged 50.3 ± 16.4 years (34-72 years); 38 cases with icterus and 19 cases with hypoproteinemia; 2 cases of MTCP in the head of the pancreas.

Group C (SPDJCS) included 65 cases, with 45 males and 20 females, aged 51.8 ± 15.3 years (30-74 years); 50 cases with icterus and 28 cases with hypoproteinemia; 4 cases of benign lesions in the head of the pancreas, with 1 case of cystadenoma and 3 cases of MTCP.

All the patients in the three groups underwent preoperative examinations (computed tomography and /or magnetic resonance cholangiopancreatography). There was no significant difference ($P > 0.05$) among the three groups in age, ratio of benign tumour cases to malignant tumour cases, and the preoperative levels of albumin, diabetes, hemoglobin, total bilirubin, and alanine amino transferase (Table 1). Neither was there difference ($P > 0.05$) among the three groups in the clinical stage, the size of the pancreatic duct, and the texture of the pancreas are concerned (Table 2).

Methods of pancreaticojejunostomy

Group A: An external drainage tube was inserted into the pancreatic duct, and into the jejunum through choledochojunostomy stoma while the drainage tube remained in the body.^{4,5}

Table 1. Preoperative clinical data of patients in Groups A, B, and C[§]

Group	Age (year)	Hemoglobin (g/L)	Albumin (g/L)	TB (μ mol/L)	ALT (U/L)	Diabetes (n)
A (n=52)	51.2 ± 17.2	121.6 ± 13.8	33.5 ± 3.7	278.2 ± 112.5	148.7 ± 69.3	5
B (n=48)	50.3 ± 16.4	118.5 ± 12.2	33.6 ± 4.3	265.4 ± 117.2	132.9 ± 73.6	4
C (n=65)	51.8 ± 15.3	120.7 ± 13.5	32.8 ± 3.2	284.3 ± 123.2	137.6 ± 78.2	6
P	>0.05	>0.05	>0.05	>0.05	>0.05	>0.05

§: Plus-minus values are means $\pm$ SD.

Group A: with end-to-end/end-to-side invaginated anastomosis; group B: with end-to-side mucosal anastomosis; group C: with suspension pancreatic duct-jejunum end-to-side continuous suture anastomosis; TB: total bilirubin; ALT: alanine aminotransferase.

Table 2. Intraoperative clinical data of patients in Groups A, B, and C

Group	Cause of disease (n)			Clinical stage (n)		Size of pancreatic duct (n)		Texture of pancreas (n)	
	Pancreatic cancer	Ampullary carcinoma	Benign tumor	I+II	III	<3 mm	≥ 3 mm	Soft	Medium or hard
A (n=52)	34	15	3	46	3	15	37	12	40
B (n=48)	32	14	2	43	3	13	35	10	38
C (n=65)	42	19	4	55	6	20	45	17	48
P		>0.05		>0.05		>0.05		>0.05	

Group B: Operation was performed following the previously described method.^{8,9} An external drainage tube was inserted into the pancreatic duct, and into the jejunum through choledochojejunostomy stoma while the drainage tube remained in the body.

Group C: The posterior pancreatic tissue and the seromuscular layer of the jejunum were sutured 1.0-1.5 cm away from the pancreas section with 3-4 stitches of horizontal mattress suture. The wall of the jejunum was incised to form a stomata at the size of the pancreatic duct (or the diameter of the pancreas) for the insertion of an external drainage tube. Continuous suture was performed between the end of the pancreas section and the seromuscular layer of the jejunum from the inferior margin (or superior margin) of the pancreas using 4-0 prolene suture. With the same suture, continuous suture was conducted between the posterior wall of the pancreatic duct and the posterior wall of the jejunum stomata. When suturing the pancreatic duct, the needle was inserted from the pancreatic duct (suture as deep as possible and with as more pancreatic tissue as possible) and pulled out from the end side of the pancreatic tissue around the pancreatic duct, thereby sewing the pancreatic tissue and the pancreatic duct together. Then the posterior wall of the jejunum, which had a stomata on

it, was sutured all the way to the superior margin (or inferior margin) of the pancreas. It required 2-3 stitches according to the size of the pancreatic duct (Figs. 1, 2). The suture was tightened after the whole posterior wall was sewed up to allow the orifice of the pancreatic duct to be naturally dilated and the pancreas fully suspensory. With the same technique, the antetheca of the pancreatic duct was sutured all the way to the pancreatic duct. The needle was inserted from pancreatic tissue around the pancreatic duct and pulled out from inside of the duct to suture the pancreatic tissue together with the pancreatic duct. The two sutures in the antetheca and the posterior wall were tied. The last step was to perform interrupted suture between the anterior margin of the end of the pancreas section and the seromuscular layer of the jejunum.

Postoperative management

The three groups received postoperative administration of antibiotics and gastric acid inhibitors, vitamin K, B, and C supplement, and maintenance of water-electrolyte balance. Somatostatin therapy at 3-5 days was also prescribed. The blood glucose was monitored. Blood plasma and albumin were given accordingly once hyperglycemia was diagnosed. Patients in good condition may undergo enteral nutrition

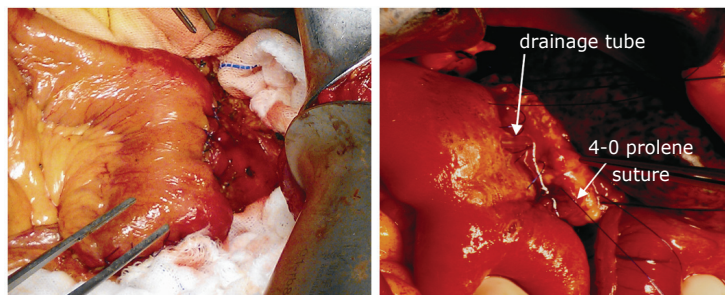


Figure 1. The left figure shows the posterior wall after pancreaticojejunostomy with suspension pancreatic duct-jejunum end-to-side continuous suture anastomosis (SPDJCS) when the suture is not tightened. The diameter of the pancreatic duct is about 3 mm and 3 stitches were performed when suturing the posterior wall of the pancreatic duct with the jejunum wall. The right figure shows the finished anastomosis.

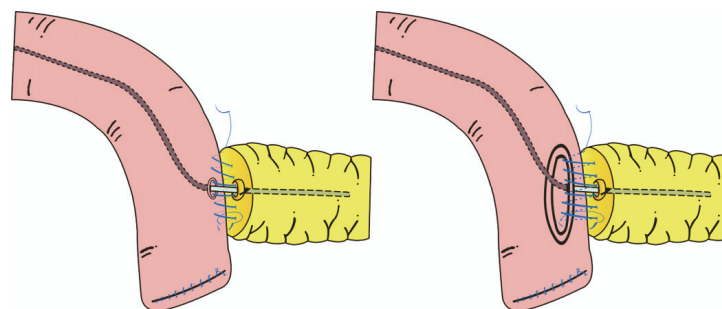


Figure 2. The left figure shows the method of SPDJCS that cuts the wall of the jejunum to form a stomata at the size of the pancreatic duct, a continuous suture was performed between the stomata and part of the posterior wall. The right figure shows the method of SPDJCS that cuts the wall of the jejunum to form a stomata at the size of the pancreas, a continuous suture between the stomata and part of the posterior wall.

support through jejunal nutrient canal 48-72 hours after the operation. Patients diagnosed as developing pancreatic fistula were treated accordingly.

Grading standard of pancreatic fistula

Among various grading standards for pancreatic fistula nowadays, the grading standard put forward by The International Study Group on Pancreatic Fistula (ISGPF) is widely accepted for its reasonableness.¹⁰⁻¹³ This standard defines that pancreatic fistula could be diagnosed if concentration of diastase in the peritoneal drainage flow is 3 times higher than the concentration of serum amylase 3 days after the operation. Pancreatic fistula is classified into grades A, B, and C based on its clinical influence on the patients. Grade A is temporary pancreatic fistula accompanied by increased pancreatin in the drainage flow but no clinical symptoms. Grade B is pancreatic fistula with fever, abdominal pain, vomiting, abdominal signs, incapability of eating, and peripancreatic effusion. Grade C is pancreatic fistula with worse clinical symptoms and more obvious peripancreatic effusion compared with Grade B.¹³⁻¹⁵

Statistical analysis

The statistical analysis was performed with SPSS 11.5. The data were expressed in frequency and percentage, analyzed using χ^2 test. $P < 0.05$ was considered statistically significant.

RESULTS

The total incidence of pancreatic fistula was 13.9% (23/165), which was 23.1% (12/52) in Group A, 18.8% (9/48) in Group B, and 3.1% (2/65) in Group C, the lowest among the 3 groups ($P < 0.05$, Table 3). Among the 12

patients who developed pancreatic fistula in Group A, 6 were classified into grade A pancreatic fistula, 4 into grade B, and 2 into grade C. Among the 9 patients with pancreatic fistula in Group B, 5 were in grade A pancreatic fistula, 3 in grade B, and 1 in grade C. The 2 patients with pancreatic fistula in Group C were all classified into grade A. Group C had significantly better results than Groups A and B in operation time, volume of intraoperative blood loss, and amount of postoperative peritoneal drainage flow ($P < 0.05$), while no significant difference was noticed between Group A and Group B ($P > 0.05$). In respect of complications other than pancreatic fistula such as peritoneal hemorrhage, peritoneal abscess, delayed gastric emptying, pulmonary infection, and postoperative infection, there was no significant difference among the three groups ($P > 0.05$). One case of perioperative death occurred in Group A due to peritoneal hemorrhage (Table 3).

DISCUSSION

Among all the complications of pancreaticoduodenectomy, one of the most common and severe was pancreatic fistula, with an incidence of 5%-40%.¹ The mortality caused by secondary peritoneal infection and hemorrhage as a result of corrosion of large vessels, both triggered by pancreatic fistula, was as high as 20%-50%.² There are many factors influencing the incidence of pancreatic fistula, including age, size and texture of the pancreas, diameter of the pancreatic duct, preoperative nutriture, bilirubin level, and above all, the type of pancreaticojejunostomy, the only controllable factor. Therefore, it is an urgency to improve the technique of pancreaticojejunostomy. The authors of this article have created a new type named "suspension pancreatic duct-jejenum end-to-side continuous suture anastomosis" during clinical practices, which yields optimal clinical effect.

Table 3. Operation-related indexes and postoperative complications among the 3 Groups

Group	Operation time (hour, $\bar{x} \pm s$)	Intraoperative blood loss (mL, $\bar{x} \pm s$)	Peritoneal drainage flow (mL, $\bar{x} \pm s$)	Pancreatic fistula [n (%)]	Peritoneal Hemorrhage [n (%)]	Classification of pancreatic fistula (n)		
						Grade A	Grade B	Grade C
A (n=52)	6.1 $\pm$ 1.1*	525.0 $\pm$ 217.0*	275.0 $\pm$ 80.0*	12 (23.1)*	2 (3.1)	6	4	2
B (n=48)	6.3 $\pm$ 1.5*	514.0 $\pm$ 217.0*	255.0 $\pm$ 75.0*	9 (18.8)*	1 (2.1)	5	3	1
C (n=65)	5.5 $\pm$ 1.2	412.0 $\pm$ 205.0	175.0 $\pm$ 65.0	2 (3.1)	1 (1.5)	2	0	0
Group	Peritoneal abscess [n (%)]	Delayed gastric emptying [n (%)]	Pumonary infection [n (%)]	Postoperative Infection [n (%)]	Blood Transfusion [n (%)]	Perioperative mortality [n (%)]		
A (n=52)	1 (3.1)	6 (11.5)	2 (3.1)	4 (7.7)	4 (7.7)		1	
B (n=48)	1 (2.1)	5 (10.4)	2 (4.2)	3 (6.3)	3 (6.3)		0	
C (n=65)	2 (3.1)	8 (12.3)	3 (4.6)	5 (7.8)	5 (7.8)		0	

* $P < 0.05$ compared with Group C

In the present study, the novel technique called SPDJCS was applied and evaluated. The results showed that the incidence of pancreatic fistula in the group of SPDJCS (Group C) was 3.1%, significantly lower than that of Group A (23.1%) and Group B (18.8%) ($P < 0.05$), while Groups A and B displayed no difference ($P > 0.05$). The reason may lie in the advantages of SPDJCS: first, the continuous suture is simple and reliable because it is free from restriction of the pancreatic duct's size, hence no leakage; second, the suture also maintains the advantages of the conventional end-to-side mucosal anastomosis; third, the patency and fastness of anastomosis are guaranteed since the suture of pancreatic duct involves both the duct itself and the pancreatic parenchyma around it; fourth, the rate of pancreas section hemorrhage and leakage are decreased because the pancreatic section and jejunum are tightly sutured without any dead space.

In clinical practices, we recommend the following procedures when performing the SPDJCS anastomosis: 1. keep the stitch distance at 0.3-0.4 cm in continuous suture, suture as much pancreatic parenchyma as allowed, and tighten the 4-0 prolene suture after one layer is sutured; 2. involve as much pancreatic duct and the surrounding pancreatic parenchyma as possible when suturing pancreatic duct, 2-3 stitches are needed according to the size of the pancreatic duct.

It was also proved in this study that the operation time of Group C was much shorter than that of groups A and B, and the intraoperative blood loss and postoperative drainage amount of plasma tubes of Group C much lower (all $P < 0.05$). The explanation may be the simplicity and convenience of SPDJCS compared with the conventional end-to-side mucosal anastomosis, therefore less demanding in operation time. There was no significant difference among the three groups in respect of other complications besides pancreatic fistula, such as peritoneal hemorrhage, peritoneal abscess, delayed gastric emptying, pulmonary infection, and postoperative infection.

According to the data of the three groups, no difference was displayed in respect of the preoperative and intraoperative status. However, in the group anastomosed with SPDJCS, the incidence of pancreatic fistula, the operation time, and the intraoperative blood loss were greatly decreased, while showing no difference in other complications. Therefore, SPDJCS may be a safe, convenient, and efficient type of anastomosis for pancreaticojejunostomy.

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