J Hepatobiliary Pancreat Surg (2008) 15:366–372
DOI 10.1007/s00534-008-1330-1

Journal of HBP Surgery

Transection using bipolar scissors reduces pancreatic fistula after distal pancreatectomy

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Abstract
Background/Purpose. Various methods and technique for treating the surgical stump of the remnant pancreas have been reported to reduce pancreatic fistula after distal pancreatectomy (DP). However, appropriate surgical stump closure after DP is still controversial. We aimed to clarify whether using bipolar scissors in DP reduces pancreatic fistula compared to hand-sewn suture of surgical stump closure.
Methods. Between January 1989 and December 2005, hand-sewn suture of surgical stump closure was performed ($n = 49$), and bipolar scissors was prospectively performed between January 2006 and July 2007 ($n = 26$).
Results. The overall rate of pancreatic fistula after DP was 22 patients (29%). There were significant differences between the hand-sewn suture group (41%) and bipolar scissors group (8%) concerning pancreatic fistula ($P = 0.0164$). A multivariate logistic regression analysis revealed that two factors, soft pancreas and hand-sewn suture compared to bipolar scissors, were independent risk factors of pancreatic fistula after DP ($P = 0.011$ and 0.0361, respectively).
Conclusions. Bipolar scissors for transection of the pancreas is a useful device to reduce pancreatic fistula after DP.

Key words Bipolar scissors · Pancreatic fistula · Distal pancreatectomy

Introduction

The morbidity rate after distal pancreatectomy (DP) remains high (20%–50%), although the mortality rate has decreased to less than 5% by recent advances in surgical techniques and perioperative management.[1–5] Pancreatic fistula has been reported as the most serious complication of morbidity and is associated with a higher incidence of other severe complications, such as intraabdominal abscess or intraabdominal bleeding.[6–10] Hand-sewn suture of the surgical stump of the remnant pancreas during DP has been the standard management for many years, but the pancreatic fistula rate by this conventional method remains high.[11–21] Therefore, various methods and techniques for treating the surgical stump of the remnant pancreas have been reported to reduce pancreatic fistula after DP.[22] However, appropriate surgical stump closure after DP is still controversial.

Bipolar scissors (Ethicon Endo-Surgery, Cincinnati, OH, USA) is a device that combines cutting with coagulation, and current crosses only between the two forceps of the electrode. This instrument has the characteristic of less thermal injury of the cut surface and better hemostasis. Although bipolar scissors have been used as a beneficial device in various fields of gastrointestinal surgery, there are only a few reports concerning the utility of this device in parenchymal organs.[23–25] Moreover, no previous reports have discussed whether using bipolar scissors in pancreatic transection reduced the pancreatic fistula rate. We conducted this prospective study to clarify whether using bipolar scissors in distal pancreatectomy reduces pancreatic fistula compared to hand-sewn suture for surgical stump closure.

Methods

Patients

From January 1989 to July 2007, 75 consecutive patients underwent DP at Wakayama Medical University Hospital (WMUH). We assigned the patients into two groups (by operative procedure) to assess the utility of bipolar scissors (Ethicon Endo-Surgery, Cincinnati, OH, USA). Between January 1989 and December 2005, hand-sewn suture of surgical stump closure was per-

Offprint requests to: H. Yamaue
Received: January 20, 2008 / Accepted: February 20, 2008

formed in 49 patients. Between January 2006 and July 2007, DP using bipolar scissors was prospectively performed in 26 patients.

Patient characteristics in the two groups were reviewed for the following clinical variables: age, gender, history of diabetes mellitus, histological diagnosis (malignant or benign), operative time, intraoperative bleeding, red blood cell transfusion, pancreatic texture (soft or hard), lymph node dissection (D1 or D2), technique of surgical stump closure (hand-sewn suture or bipolar scissors), combined portal vein resection, combined celiac artery resection, and contiguous organs resection.

The protocol and study design of distal pancreatectomy using bipolar scissors were conducted according to the guidelines of the Ethical Committee of WMUH.

Operative procedure and postoperative management

In the hand-sewn suture group, the pancreas was transected with a knife following the identification of the main pancreatic duct, and then the main pancreatic duct was ligated by 3-0 silk. The surgical stump of the remnant pancreas was closed by a single vertical mattress suture using 4-0 polypropylene. In the bipolar scissors group, the pancreas was transected using bipolar scissors (Ethicon Endo-Surgery). During the transection of the pancreas, small pancreatic ducts and vessels as well as the main pancreatic duct were adequately exposed, ligated proximally by 3-0 silk, and divided. The surgical stump of the remnant pancreas was left open without parenchymal suturing.

One 10-mm Penrose drain, a silicon, multitubular flat drain, routinely was placed near the stump of the remnant pancreas. The drain was to be removed on POD 4 to prevent intraabdominal abscess when the drainage fluid was clear and pancreatic fistula and bacterial contamination were absent.[6] Serum amylase and drainage fluid were measured on postoperative day (POD) 1 and 4. No patient received radiotherapy preoperatively or postoperatively. All patients received prophylactic antibiotics intraoperatively and for 2 days postoperatively. Prophylactic octerotide to prevent pancreatic fistula was not administered.

Postoperative complications

Pancreatic fistula was defined as more than 50 ml drainage fluid per day with threefold serum amylase level on POD 4. Intraabdominal abscess was defined as intraabdominal fluid collection with positive cultures identified by ultrasonography or computed tomography (CT) associated with persistent fever and elevation of white blood cells. Infected intraabdominal fluid was defined as drainage fluid that had a positive culture with clinical signs, but without detected intraabdominal abscess.

Statistical analysis

Data were expressed as means ± SD. Patient characteristics and perioperative and postoperative factors between the two groups were compared by using chi-square statistics, Fisher's exact test, and the Mann–Whitney U test. Variables with $P < 0.100$ were entered into a logistic regression model to determine independent risk factors of postoperative complications. The independent risk factors of the variables were expressed as odds ratios with their 95% confidence intervals. Statistical significance was defined as $P < 0.05$.

Results

Patient characteristics and postoperative complications

Seventy-five patients who underwent DP were divided into two groups: 49 patients received DP with hand-sewn suture, and 26 patients received DP using bipolar scissors.

Table 1 shows the results of patient characteristics and preoperative status and histological analyses of the resected specimens. There were no significant differences concerning malignant (hand-sewn suture: $n = 30$; bipolar scissors: $n = 17$) and benign (hand-sewn suture: $n = 19$; bipolar scissors: $n = 9$) tumors between the two groups ($P = 0.9148$).

Intraoperative findings

Table 2 shows perioperative status. There were no significant differences between the two groups concerning intraoperative bleeding, red blood cell transfusion, pancreatic texture, portal vein resection, celiac artery resection, or contiguous organ resection. However, operative time (339 min vs 357 min) and red blood cell transfusion in patients (20% vs 8%) with hand-sewn suture were significantly increased compared with the bipolar scissors group ($P = 0.033$ and 0.014, respectively).

Postoperative complications after distal pancreatectomy

Table 3 shows the results of postoperative complications and mortality. The overall rate of pancreatic fistula was 22 patients (29%). There were significant differences between the two groups concerning pancreatic fistula (hand-sewn suturing group, 41% vs bipolar scis-

Table 1. Characteristics of the enrolled patients

	Hand-sewn suture ($n = 49$)	Bipolar scissors ($n = 26$)	P value
Age	62 ± 13	65 ± 12	0.6205
Sex (male/female)	26/23	12/14	0.7414
Diabetes (yes/no)	11/38	9/17	0.1876
Benign tumors/malignant tumors	19/30	9/17	0.9148
Pancreatic adenocarcinoma	28	18	
Tumor-forming pancreatitis	6	4	
Intraductal papillary neoplasms	5	2	
Serous cyst adenoma	2	2	
Mucinous cystic tumor	5	0	
Other diseases	3	0	

Table 2. Comparison of perioperative status

	Hand-sewn suture ($n = 49$)	Bipolar scissors ($n = 26$)	P value
Operative time (min)	296 ± 107	208 ± 72	0.0030
Intraoperative bleeding (ml)	1183 ± 1215	805 ± 793	0.1564
RBC transfusion (yes/no)	10/39	2/24	0.1979
Pancreatic texture (soft/hard)	26/23	12/14	0.5752
Lymph node dissection (D1/D2)	7/42	4/22	0.9999
Portal vein resection (yes/no)	4/45	1/25	0.4824
Celiac artery resection (yes/no)	3/46	5/21	0.1731
Contiguous organ resection[a] (yes/no)	10/39	1/25	0.0847

[a] Contiguous organs: stomach, transverse colon, and left adrenal gland

Table 3. Comparison of postoperative complications and mortality

	Hand-sewn suture ($n = 49$)	Bipolar scissors ($n = 26$)	P value
Postoperative complications	27 (55%)	7 (27%)	0.0196
Pancreatic fistula[a]	20 (41%)	2 (8%)	0.0164
Intraabdominal abscess	10 (20%)	2 (8%)	0.4014
Intraabdominal hemorrhage	2 (4%)	1 (4%)	0.9999
Gastrointestinal hemorrhage	0	0	—
Delayed gastric emptying	0	0	—
Pseudocyst	7 (14%)	3 (12%)	0.9420
Mortality	0	0	—

[a] Pancreatic fistula: more than 50 ml drainage fluid per day with more than threefold serum amylase level on postoperative day 4

sors group, 8%; $P = 0.0164$). There were no significant differences between the two groups concerning other complications. Mortality rate was 0%.

Risk factors of pancreatic fistula after distal pancreatectomy

Univariate and multivariate analysis were used to reveal risk factors for pancreatic fistula after distal pancreatectomy. Table 4 shows the results of 13 parameters univariately examined as risk factors for the 22 patients with pancreatic fistula versus the 53 patients without pancreatic fistula. Two intraoperative factors (soft pancreas, $P = 0.00270$; hand-sewn suture, $P = 0.0030$) differed significantly between these two groups. A multivariate logistic regression analysis revealed that two factors, that is, soft pancreas and hand-sewn sutures compared to bipolar scissors, were independent risk factors of pancreatic fistula after DP ($P = 0.011$ and 0.0361, respectively) (Table 5).

Table 4. Univariate analysis of risk factors influencing pancreatic fistula after distal pancreatectomy

	Pancreatic fistula (+) ($n = 22$)	Pancreatic fistula (−) ($n = 53$)	P value
Age			
≤65	7	27	
>65	15	26	0.2064
Sex			
Male	12	26	
Female	10	27	0.8551
Diabetes			
Yes	7	13	
No	15	40	0.7136
Histology			
Benign	5	23	
Malignant	17	30	0.1538
Operative time (min)			
≤240	7	31	
>240	15	22	0.0638
Intraoperative bleeding (ml)			
≤1000	12	33	
>1000	10	20	0.7145
Red blood cell transfusion			
Yes	3	9	
No	19	44	0.9853
Pancreatic texture			
Soft	16	22	
Hard	6	31	0.0270
Lymph node dissection			
D1	4	7	
D2	18	46	0.7213
Portal vein resection			
Yes	0	5	
No	22	48	0.3132
Celiac artery resection			
Yes	1	7	
No	21	46	0.4237
Contiguous organ resection[a]			
Yes	1	10	
No	21	43	0.1587
Surgical stump closure			
Hand-sewn suture	20	29	
Bipolar scissors	2	24	0.0030

[a] Contiguous organs: stomach, transverse colon, and left adrenal gland except spleen

Table 5. Multivariate analysis of risk factors influencing pancreatic fistula after distal pancreatectomy

Risk factor	P value	Odds ratio	95% Confidence interval
Soft pancreas	0.0110	4.9	1.4–16.5
Hand-sewn suture	0.0361	5.9	1.1–31.0

Discussion

The standard treatment for surgical stump after distal pancreatectomy (DP) is hand-sewn suture. However, the pancreatic fistula rate after DP with a conventional hand-sewn suture technique is between 9% and 40%.[11–21] The mechanism of pancreatic fistula after hand-sewn suture in DP has been thought to be minimal ischemic necrosis of the sutured surgical stump and persistent extravasation of pancreatic juice from incompletely sealing the small duct.

In this study, bipolar scissors were used in pancreatic transection to reduce pancreatic fistula after DP. There is no report concerning the utility of this device in pancreatic parenchyma, although bipolar scissors has been used as a beneficial device in various fields of gastrointestinal surgery. Carbonization and excessive coagulation of the tissue using electrosurgical devices are reported to be reduced when the electrode–tissue interface produces less than 600 V during the operation.[26,27] Bipolar scissors have sensor electronics to regulate the

Table 6. The management of surgical stump in distal pancreatectomy

Reference	Study design	Sample size	Management of surgical stump	Pancreatic fistula rate (%)	Definition of pancreatic fistula
1. Fahy BN[11]	Retrospective study	51	Stapled suture	13%	Persistent drainage fluid for more than 7 days or drain amylase level more than 5000 IU/l
			Hand-sewn suture	36%	
2. Bilimoria MM[12]	Retrospective study	126	Stapled suture	20%	Drain amylase level more than 3-fold normal serum amylase level after POD3
			Hand-sewn suture	22%	
			Stapled suture + hand-sewn suture	13%	
3. Kleeff JK[13]	Retrospective study	302	Stapled suture	16%	More than 30 ml drainage fluid per day with more than 5000 units drain amylase level for more than 10 days or the necessity for interventional drainage of an amylase-rich fluid collection
			Hand-sewn suture	9%	
			Seromuscular patch	8%	
			Anastomosis	0%	
4. Pannegeon V[14]	Retrospective study	175	Stapled suture	22%	Drain amylase level more than 3-fold normal serum amylase level after POD5
			Hand-sewn suture	21%	
5. Ridolfini MP[15]	Retrospective study	64	Stapled suture	26%	Drain amylase level more than 3-fold normal serum amylase level on POD3
			Hand-sewn suture	20%	
6. Thaker RI[16]	Prospective study	40	Stapled suture + mesh	3.5%	Amylase-rich drainage fluid at any time or fluid collection requiring drains or antibiotics
			Stapled suture	22%	
7. Suzuki Y[17]	Randomized controlled study	58	Ultrasonic dissection	4%	Persistent drainage fluid for more than 7 days with amylase level more than 3-fold normal serum amylase on POD7
			Hand-sewn suture	26%	
8. Sugo H[18]	Retrospective study	31	Ultrasonically activated scalpel	0%	Drain amylase level more than 3-fold normal serum amylase level on POD7 or persistent pancreatic fluid for more than 7 days
			Hand-sewn suture	30%	
9. Suzuki Y[19]	Randomized controlled study	56	Hand-sewn suture + fibrin glue	15%	Persistent drainage fluid for more than 7 days with amylase level more than 3-fold normal serum amylase on POD7
			Hand-sewn suture	40%	
10. Suc B[20]	Randomized controlled study	182 (PD 141 + DP 41)	DP with fibrin glue	18%	Persistent drainage fluid for more than 3 days with amylase level more than 4-fold normal serum amylase
			DP without fibrin glue	16%	
11. Wagner M[21]	Retrospective study	44	Anastomosis	0%	More than 30 ml drainage fluid per day with more than 5000 units drain amylase level for more than 10 days
			Hand-sewn suture	20%	
12. Present study	Retrospective study	75	Bipolar scissors	8%	More than 50 ml drainage fluid per day with amylase level more than 3-fold normal serum amylase on POD 4
			Hand-sewn suture	41%	

POD, postoperative day; PD, pancreaticoduodenectomy; DP, distal pancreatectomy

energy delivery to the lowest level (peak voltage, <600 V), and in the bipolar delivery system, current crosses only through the tissue held between the two forceps. Bipolar scissors reduce coagulation necrosis of the cut surface, as the risk of current splitting to the cut surface of the pancreas and subsequent tissue damage are minimized. Moreover, the small duct as well as the main pancreatic duct were easily found during transection of the pancreatic parenchyma using bipolar scissors and then ligated tightly.

In this study, there were significant differences concerning pancreatic fistula between the hand-sewn suture group (41%) and the bipolar scissors group (8%). Two groups have significantly different intraoperative findings, operative time and transfusion of red blood cells, although these factors were not independent risk factors of pancreatic fistula. One should consider that the bias of the presented study lies in increasing experience over time (in the second period of the study) concerning operative time and transfusion of red blood cells. By multivariate analysis in this study, we clarified two independent risk factors of pancreatic fistula, soft pancreas and hand-sewn suture, compared to bipolar scissors for treatment of the surgical stump. To our knowledge, the use of bipolar scissors in transection of the pancreas is the first technique to reduce pancreatic fistula after DP.

Table 6 shows the relationship between the management of surgical stump in DP and pancreatic fistula in previous reports.[11–21,28] Various methods and techniques for treating surgical stump of the remnant pancreas, such as stapled closure,[11–15] application of meshes,[16] ultrasonic dissection,[17] ultrasonically activated scalpels,[18] seromuscular patch application of meshes,[13,29] fibrin-glue sealing application of meshes,[19,20] or anastomosis[13,21] have been studied in an effort to reduce pancreatic fistula occurrence after DP. Stapled closure has already been reported to be a simple, quick, and secure instrument for pancreatic stump closure. Many studies reported that the use of stapled closure reduced pancreatic fistula compared to hand-sewn sutures. However, Kleeff et al. have proposed the opposite result, that hand-sewn suture was superior to stapled suture as to pancreatic fistula: hand-sewn suture, 9.3% versus stapled suture, 15.9%.[13] Systematic review and meta-analysis of technique for closure of pancreatic remnant after DP have been reported not to confirm a statistically significant reduction with regard to pancreatic fistula after DP, although there was a trend in favor of stapled suture.[30] Mesh reinforcement of stapled closure was studied to distribute tension at the resection margin or to protect small lacerations and gaps in the staple line.[16] This technique by mesh reinforcement was reported to reduce the pancreatic fistula rate from 22% to 3.5%. Suzuki et al. have proposed pancreatic transection using ultrasonic dissection reduced pancreatic fistula from 26% by hand-sewn suture to 4% in a randomized controlled study.[17] The ultrasonically activated scalpel, which uses high-frequency vibrations for cutting and coagulation, has been reported to reduce pancreatic fistula compared to hand-sewn suture (0% vs 30%).[18] These devices cause less thermal injury of cut surface and adequately expose the main pancreatic duct the same as bipolar scissors. Two studies have reported the use of seromuscular pancreatic patch to prevent pancreatic fistula. The technique, in which the surgical stump of the remnant pancreas is completely covered with the gastric wall, is a fast procedure with cost benefits.[13,29] The drawback of this technique was reported to increase delayed gastric emptying (13.9%), although this method reduced pancreatic fistula compared to the other stump closures.[13] The use of fibrin glue for the surgical stump was reported to reduce pancreatic fistula from 40% to 15% compared to hand-sewn sutures,[19] although it was reported there was no significant difference with or without the use of fibrin glue.[20]

Bipolar scissors for transection of the pancreas significantly reduced pancreatic fistula after DP compared to hand-sewn sutures in this study. A randomized controlled trial should be undertaken to make these data much more convincing. However, we believe that bipolar scissors will become one of the beneficial choices of approach for pancreatic resection in DP.

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