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Pancreatic Transection with Cavitron Ultrasonic Surgical Aspirator versus Electrocautery in Pancreaticoduodenectomy for Prevention of Postoperative Pancreatic Fistula

Yasuyuki Suzuki[1], Keiichi Okano[1], Shinichi Yachida[1], Minoru Ohshima[1], Hirotaka Kashiwagi[1], Naoki Yamamoto[1], Shintaro Akamoto[1], Masao Fujiwara[1], Hisashi Usuki[1], Hideki Kamada[2], Hirohito Mori[2] and Tsutomu Masaki[2]*

[1]*Departments of Gastroenterological Surgery, Kagawa University, Japan*

[2]*Department of Gastroenterology, Kagawa University, Japan*

Abstract

Background: Postoperative pancreatic fistula (POPF) still remains a major cause of morbidity after pancreaticoduodenectomy (PD).

Methods: This study enrolled only patients with a soft pancreas and compared two pancreatic transection devices, Cavitron ultrasonic surgical aspirator (CUSA) (group I, n=28) and electrocautery (group II, n=27), for the purpose of POPF prevention. We combined each transection technique with inner duct reconstruction with a stent and outer full-thickness pancreas-to-seromuscular jejunal anastomosis.

Results: The incidence of Grade B POPF was lower in group I (21% versus 37%) but did not differ significantly. Grade C POPF and failure of the duct reconstruction were not observed in this series. Drain amylase levels higher than 5,000 IU/L on POD 1 and higher than 1,000 IU/L and 2,000 IU/L on POD 3 were significantly less common in group I (P=0.01 and P=0.04). Conclusion; Postoperative leak of pancreatic juice was more effectively controlled by the CUSA transection although clinical POPF incidence did not reduce significantly.

Keywords: CUSA, Pancreatic transaction; Pancreatic fistula; Pancreaticoduodenectomy

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Correspondence:
Yasuyuki Suzuki, Departments of Gastroenterological Surgery, Kagawa University, 1750-1 Ikenobe, Miki-cho, Kita, Kagawa, 761-0793, Japan, Tel: +81-87-891-2438; Fax: +81-87-891-2439;
E-mail: szk@med.kagawa-u.ac.jp

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Introduction

Postoperative pancreatic fistula (POPF) still remains a major cause of morbidity after pancreaticoduodenectomy (PD). A variety of pancreatic reconstruction techniques have been recommended to reduce POPF, including duct-to-mucosa anastomosis with or without a stent [1-3], pancreatic invagination anastomosis [4,5], binding pancreaticojejunostomy [6], pancreatogastrostomy [7], and so on. However, there have been a few studies that evaluate beneficial effect of pancreatic transection technique on POPF prevention [8,9].

So far, we have advocated the use of Cavitron ultrasonic surgical aspirator (CUSA) for pancreatic transection in PD from a viewpoint of POPF prevention. CUSA dissects pancreatic parenchyma and exposes nonparenchymal structures including branch pancreatic ducts and small blood vessels, which can be ligated and divided in sequence. In our previous one-arm studies, pancreatic parenchyma was not sutured to the jejunum [5,10]. Meanwhile, in Japan, close approximation of pancreatic cut surface to the jejunum by placing 4 or 5 large stitches of non-absorbable sutures (Kakita's procedure) [11] following the inner pancreatic duct anastomosis has been a stable and popular reconstruction procedure in recent years. This is the first study to compare two pancreatic transection devices, CUSA and electrocautery, combined with a Japan standard reconstruction procedure.

Patients and Methods

Informed consent was obtained from the patients and approval was obtained from the designated review board of the institution involved.

Table 1: Patient Characteristics and Perioperative Parameters.

	CUSA (n=28)	Electrocautery (n=27)	P
Age(years)	64.1+/-14.0 (33-82)	63.9+/-15.5 (9-85)	0.97
Sex ratio (F:M)	13:15	14:13	0.69
Diagnosis			NS
Pancreatic cancer	2	2	
Bile duct cancer	8	3	
Ampullary cancer	3	5	
IPMN	5	3	
NET	4	5	
Gallbladder cancer	1	1	
Duodenal cancer	1	3	
Solid pseudopapillary tumor	3	0	
Trauma	1	2	
Colon cancer	0	2	
Metastatic tumor	0	1	
Pancreatic duct size	2.71+/-1.83 (1-10)	2.44+/-1.81 (1-8)	0.59
Pancreatic duct < 3 mm	22	21	0.94
Whipple	11	7	0.59
PpPD	17	20	
Operation time	442 (290-710)	418 (330-606)	0.37
Estimated blood loss	614 (140-10564)	724 (94-5901)	0.28

SPT: Solid Pseudopapillary Tumor; PpPD: Pylorus-preserving Pancreaticoduodenectomy

A total of 55 consecutive patients with a soft pancreas undergoing Whipple procedure (n=18) or pylorus-preserving pancreaticoduodenectomy (PPPD, n=37) for a variety of periampullary diseases were enrolled in this study. The patient characteristics and Perioperative variables are shown in (Table 1). Twenty-eight consecutive patients underwent surgery between June 2007 and March 2010 (group I) and subsequent 27 between April 2010 and December 2011 (group II) in Kagawa University Hospital. In group I, the pancreas was transected with a CUSA (CUSA system™, Cooper Medical Devices Corp., Mountainview, CA, USA) at the lowest vibration level. During the transection, pancreatic parenchyma was dissected and suctioned, and nonparenchymal thread-like structures including branch pancreatic ducts and small blood vessels were ligated with 4-0 silk sutures and divided [5]. The main pancreatic duct was cut with a scissors. In contrast, in group II, we used an electrocautery to divide the pancreatic parenchyma and finally a scissors to cut the main pancreatic duct with the surroundings. Subsequently, we performed duct-to-mucosa anastomosis usually with 8 5-0 polydioxanone sutures (PDS-II®, Ethicon, Johnson and Johnson, Co., USA) or duct-invagination anastomosis [5], both with a 4 Fr internal stent (Suikan tube®, Sumitomo Bakelite Co., Ltd, Tokyo, Japan) inserted into the pancreatic duct. Then, it was followed by placing 4 or 5 full thickness pancreas-to-seromuscular jejunal stitches of 3-0 polypropylene sutures (Prolene®, Ethicon, Johnson and Johnson Co., USA) to approximate pancreatic cut surface closely to the jejunal wall (Kakita's procedure) [11]. The all pancreases in this series were estimated intraoperatively to have soft texture by attending surgeons. Main pancreatic duct diameter was measured with an intraoperative ultrasonography and did not differ significantly between the groups (2.71±1.83 mm and 2.44±1.81 mm in groups I and II, respectively). The small duct (≤ 3 mm) was seen in 22 and 21 patients in groups I and II, respectively. The reconstructions of the bile duct and the stomach or proximal duodenum were completed according to the Child's procedures. Two closed suction drains were placed in the anterior and posterior vicinities of the pancreaticojejunostomy. The same team of three senior surgeons carried out all 55 PDs in this series. Estimated blood loss and operation time were not different between the groups.

Table 2: Postoperative Outcomes.

	CUSA (n=28)	Electrocautery (n=27)	P
Mortality (%)	0 (0)	1 (4)	0.3
Morbidity (%)	16 (57)	11 (41)	0.22
POPF (%)	6 (21)	10 (37)	0.2
DGE (%)	2 (7)	2 (7)	
Wound infection (%)	3 (11)	2 (7)	
Abdominal abscess (%)	3 (11)	1 (4)	
Pneumonia (%)	2 (7)	1 (4)	
Others (%)	3 (11)	3 (11)	

POPF, Postoperative pancreatic fistula; DGE, Delayed gastric emptying

Perioperative management

A prophylactic intravenous broad-spectrum antibiotic was started intraoperatively, followed by the same antibiotic every 12 h for up to postoperative day (POD) 3. Once an infective complication was detected, an antibiotic that was sensitive to the cultured pathogen was selected and administered. Prophylactic octreotide and erythromycin lactobionate were not routinely used in this series. Early enteral nutrition was routinely started on POD 2 or 3 until patients resumed sufficient oral diet. An oral diet was started typically between POD 4 and POD 6 after the first sign of bowel activity was detected. Drain

Table 3: Drain Amylase Levels on PODs 1 and 3.

	CUSA (n=28)	Electrocautery (n=27)	P
D-amylase (POD1)	7502 (391-345200)	15021 (164-246800)	0.34
>5000 (%)	14 (50)	22 (81)	0.01
>10000 (%)	11 (39)	15 (56)	0.23
D-amylase (POD3)	536 (31-101150)	1719 (24-93730)	0.67
>500 (%)	15 (54)	20 (74)	0.11
>1000 (%)	11 (39)	18 (67)	0.04
>2000 (%)	7 (25)	14 (52)	0.04

Amylase levels are shown as IU/L.

amylase levels were determined in all patients on POD 1, POD 3, and occasionally on POD 5. The POPF was diagnosed based on the ISGPF definition and classification [12]. In this study, only grades B and C POPF was included in postoperative complications as clinically relevant POPF, although grade C was not detected in this series. Once POPF was diagnosed, the treatment consisted of appropriate drainage through an intraoperatively placed drain or image-guided percutaneous drain, administration of sensitive antibiotics and occasional use of octreotide.

Statistical analyses

Continuous data were expressed as mean±SD (range) or median (range) and were compared using the Student's t-test. The chi-square test or the Fisher exact test was used as appropriate for analysis of categorical variables. Statistical significance was defined as $P< 0.05$. Statistical analyses were carried out using SPSS® version 14.02 (SPSS, Chicago, Illinois, USA) software.

Results

Postoperative outcomes are summarized in (Table 2). One patient with underlying interstitial pneumonitis was complicated with rapidly progressive respiratory failure from POD 3 and eventually died on POD 23. The mortality rate was 1.8% but not associated with POPF in this series. The overall morbidity rates were 57% and 41% in groups I and II, respectively (P=0.22). Grade B POPF occurred in 6 (21%) and 10 (37%) patients but grade C POPF was not diagnosed. Failure of the duct reconstruction was not observed in this series. The incidence of POPF was lower in group I but did not differ significantly between the groups (P=0.2). Then, we analyzed drain amylase levels (higher ones in two drains placed intraoperatively) in POD 1 and POD 3 (Table 3) and the large variations were observed in the levels among the patients. However, drain amylase level higher than 5,000 IU/L on POD 1 was significantly less common in group I compared to group II (50% and 81% in groups I and II, respectively, P=0.01). In addition, on POD 3, patients with drain amylase levels higher than 1,000 IU/L and 2,000 IU/L were less frequently seen in group I than group II (P=0.04). From these results, postoperative leak of pancreatic juice was more effectively controlled by CUSA transection of the pancreas.

Discussion

POPF is still the most common and occasionally life-threatening complication after PD, especially for soft pancreas. To reduce POPF, a variety of surgical techniques have been introduced but the gold standard has not yet been established. Therefore, continuous efforts to develop and evaluate the new surgical techniques remain to be important. In this study, we enrolled only patients with a soft pancreas undergoing PD. As a number of literatures demonstrated, the gland with hard texture rarely results in POPF [10,13]. In fact, no clinically significant POPF developed in patients with a hard pancreas in our entire series of PDs, which were performed during the same period of this study. Although apparent incidences of clinically relevant POPF increase, assessment of surgical techniques could be more clearly done in a series of soft pancreas that carries a risk of POPF.

Mortality after PD has decreased below 5% in high-volume centers in these two decades [14] and the majority of patients with POPF can recently be managed conservatively with either maintenance of oral diet or parenteral nutrition until its closure [15]. From these data, it is postulated that failure in the main pancreatic duct anastomosis decreased with recent advances in surgical techniques and materials, especially in experienced centers. Clinically relevant POPFs that occur in recent years seem to originate mostly from branch pancreatic ducts open on the cut surface of the pancreas. Even small amount of pancreatic leakage can develop to clinically relevant grade B or C POPF if not well drained and infected. Thus, complete closure of branch pancreatic ducts could further reduce the rate of clinically relevant POPF.

So far, we have advocated the use of CUSA for pancreatic transection in PD in an attempt to close all visible branch pancreatic ducts [5,10]. CUSA dissects pancreatic parenchyma and exposes nonparenchymal structure including branch pancreatic ducts and small blood vessels, which can be ligated and divided in sequence. However, complete closure of all tiny ducts is technically demanding and unlikely always possible. Additionally, the CUSA transection requires 20-30 minutes. In the mean times, an outer full thickness pancreas-to-seromuscular jejunal anastomosis by placing 4 to 5 large stitches of non-absorbable sutures (Kakita's procedure) [11] following inner duct anastomosis has been a widely accepted or standard reconstruction method in Japan. Kakita's procedure is simple, not technically demanding, and also aims to reduce pancreatic leakage from branch pancreatic ducts. Pancreatic transections with a CUSA combined with the subsequent reconstruction with Kakita's technique are expected to close the branch ducts more securely. This study is the first comparative study of pancreatic transection devices, CUSA and electrocautery, combined with a Japan standard outer reconstruction procedure.

Neither grade C POPF nor death associated with POPF was seen in this series. Grade B POPF occurred in 21% and 37% in groups I and II, respectively. The clinically relevant POPF was more frequently seen in group II, but POPF rates as well as morbidity rates did not significantly differ between both pancreatic transection techniques. In contrast, there was a significant tendency that CUSA reduced amount of pancreatic juice leak on PODs 1 and 3 based on drain amylase analyses. Drain amylase levels on POD 1 were reported to be a predictor of subsequent development of POPF. Molinari E and colleagues demonstrated in 137 patients undergoing major pancreatic resections that drain amylase value in POD1 > or =5000 U/L is the significant predictive factor of PF development [16]. A recent publication based on Japan multicenter data collection reported that drain amylase level on POD 1 >4,000 IU/L were the significant predictive factors for clinical pancreatic fistula [17]. In this series, drain amylase level higher than 5,000 IU/L on POD 1 was significantly less common in group I compared to group II (50% and 81% in groups I and II, respectively, P=0.01).

Early after PD for soft and otherwise normal pancreas, drain fluid showed amylase level much higher than that in the serum in almost all cases. Another possible route of pancreatic leak is along

the threads placed to approximate pancreatic cut surface to the jejunum. Although this leak may be inevitable, it usually lasts for only a few days. We consider that reducing the volume and duration of pancreatic leak is important to minimize drain infection occasion. From the results of this study, pancreatic transection with CUSA and reconstruction with Kakita's procedure could close branch pancreatic ducts more securely and control postoperative leak of pancreatic juice more effectively, although clinical POPF rates did not significantly differ. We acknowledge that the present study has several limitations. The study design is retrospective and the number of patients is not large. A randomized study is needed to clarify a clinically relevant advantage of CUSA.

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