Assessment of Outcome After Pancreaticoduodenectomy by Junior Surgeons

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Abstract. *Background/Aim: Pancreaticoduodenectomy (PD) is one of the most complicated procedures. We retrospectively assessed the therapeutic outcome after PD by Junior surgeons. Patients and Methods: This study included 253 patients. We retrospectively analyzed surgical outcomes and long-term survivals of PDs performed by Junior surgeons (surgical training year within 10 years) as compared to those by Senior surgeons (surgical training year over 10 years). Results: Operative time was significantly longer in junior surgeons than that in Senior surgeons ($p<0.001$). Intraoperative blood loss ($p=0.079$), hospital stay ($p=0.803$), complications ($p=0.700$), mortality ($p=0.442$) were comparable between the two groups. Disease-free and overall survival rates were not statistically different between the two groups in pancreatic cancer ($p=0.248$ and $p=0.526$) and in bile duct or ampullary cancer ($p=0.873$ and $p=0.954$). Conclusion: PD performed by Junior surgeons require approximately 70 more minutes but surgery can be performed safely under appropriate patient selection, intraoperative supervision and perioperative management with comparable long-term survival.*

Pancreaticoduodenectomy (PD) was first reported by Kausch from Germany in 1912 (1). For the next 100 years, operative procedure, operation device and preoperative management of patients have improved. The in-hospital mortality after PD in the 1960s and 1970s were in the range of 25% (2). In 2010's, the reputed in-hospital mortality rate has decreased to under 2% at high-volume Centers (3). However, PD remains one of the most complex procedures in gastrointestinal surgery and perioperative complications remain high. Previous reports, which compared surgical outcomes after PD in high- and low-volume Centers demonstrated an association between the number of surgical cases per year and surgical outcome (4-8). These data indicated that therapeutic outcome after PD may be better by surgeons with extensive experience in PD than those by surgeons with limited experience. Indeed, Birkmeyer *et al*. (9) showed that experience of individual surgeon with PD is inversely related to operative mortality. Tseng *et al*. (10) compared the outcome of PD between the first and the next 60 cases by surgeons trained at three different fellowship programs, with the outcome of the next 60 cases being improved with regard to estimated blood loss, operation time, length of hospital stay and achievement of margin-negative resection. Relles *et al*. (11) reported that surgical experience of resident surgeons affect surgical outcomes of PD. However, appropriate instruction from attending surgeons may lead to acceptable outcome after PD operated by Junior surgeons. Moreover, for comparison of outcomes in relation to the same surgeons' experience, the differences in surgical techniques, devices and perioperative management by time should be considered, mainly due to modern medical advances. The aim of this study was to assess the short- and the long-term outcomes of PDs by Junior surgeons under appropriate supervision from scrubbed attending surgeons as a first assistant, compared to those operated by Senior surgeons during the same period.

Patients and Methods

We performed a retrospective review of a prospectively maintained database of 253 patients who underwent PD for pancreatic ductal adenocarcinoma (n=106), intraductal papillary mucinous adenoma ((IPMA), n=10), cholangiocarcinoma (n=56), ampullary adenocarcinoma (n=46), duodenal cancer (n=8), neuroendocrine carcinoma (n=7), chronic pancreatitis (n=6) and other cancers (n=14) between 2001 and 2012 at the Department of Surgery, Jikei University Hospital, Tokyo, Japan. This research was approved by

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Key Words: Pancreatoduodenectomy, pancreatic cancer, biliary cancer, young surgeons, learning curve.

Table I. *Univariate analysis of surgeons' and patients' characteristics.*

	Junior surgeons group (STY≤10; n=60)	Senior surgeons group (STY>10; n=193)	*p*-Value
Surgeons' STYs, years	7.8±1.7*	17.0±4.4	<0.001
Patient age, years	64.6±10.2	65.6±11.3	0.541
Gender, (male : female)	37:23	119:74	0.999
PD for malignant tumors, n (%)	53 (88)	163 (84.5)	0.458
Diagnosis			0.569
Pancreatic cancer, n (%)	30 (50)	76 (39)	
Bile duct cancer, n (%)	12 (20)	44 (23)	
Ampullary cancer, n (%)	10 (17)	36 (19)	
Duodenal cancer, n (%)	1 (2)	7 (4)	
Neuroendocrine carcinoma, n	0 (0)	7 (4)	
Chronic pancreatitis, n (%)	2 (3)	4 (2)	
IPMA, n (%)	1 (2)	9 (5)	
Others, n (%)	4 (7)	10 (5)	
Body mass index (kg/m^2)	22.3±3.3	22.2±3.1	0.895
Coexistent diseases			
Hypertension, n (%)	21 (35.0)	72 (37.3)	0.746
Diabetes mellitus, n (%)	9 (15.0)	47 (24.4)	0.127
Cardiac disease, n (%)	5 (8.3)	32 (16.6)	0.114

STY, Surgical training year; n, number; NA, not applicable; PD, pancreaticoduodenectomy; IPMA, intraductal papillary mucinous adenoma; *mean±SD.

Table II. *Intraoperative outcomes and pathological findings in pancreatic and biliary cancer.*

	Junior group (STY≤10; n=60)	Senior group (STY>10; n=193)	*p*-Value
Duration of operation, min	573.2±115.5*	507.6±122.7	<0.001
Intraoperative blood loss, ml	1475.9±1684.2	1141.4±1131.1	0.079
Portal vein resection, n (%)	7 (11.7)	20 (10.4)	0.775
Blood transfusion, n (%)	23 (38.3)	68 (35.2)	0.662
Diameter of pancreatic duct, mm**	3.3±1.3	4.0±2.8	0.221
Hard texture of the pancreas, n (%)	15 (25)	63 (33)	0.263
Pancreatic cancer (n=106)	(n=30)	(n=76)	
Stage, n (%)			0.611
0	1 (3)	5 (7)	
I	0 (0)	3 (4)	
II	4 (13)	11 (15)	
III	14 (47)	38 (50)	
IV	11 (37)	19 (25)	
Curability, n (%)			0.119
R0	18 (60)	57 (75)	
R1	11 (37)	19 (25)	
R2	1 (3)	0 (0)	
Bile duct/ampullary cancer (n=102)	(n=22)	(n=80)	
Stage, n (%)			0.697
I	5 (23)	17 (21)	
II	4 (18)	21 (26)	
III	8 (36)	20 (25)	
IV	5 (23)	22 (28)	
Curability, n (%)			0.948
Cur A	15 (68)	53 (66)	
Cur B	4 (18)	17 (21)	
Cur C	3 (14)	10 (13)	

STY, Surgical training year; n, number; R0, no residual tumor; R1, microscopic residual tumor: R2, macroscopic residual tumor; Cur A, no residual tumor without invasion of cancer cells within 5 mm of resected margin and with dissection more than pN stage (TNM classification); Cur B, no residual tumor without meeting the standards of Cur A; Cur C, residual tumor microscopically; *mean±SD, **including 125 patients.

the ethics committee of The Jikei University School of Medicine. The patients were classified into two groups: Junior surgeons group; with patients who underwent PD by surgeons whose surgical training year (STY) is equal to or less than 10 years and Senior surgeons group; with patients who underwent PD by surgeons who were STY over 10 years. In our institute, the average STY of attending surgeons, who could have all responsibilities in perioperative management of patients as a specialist of gastrointestinal surgeon, is over 10 years. Therefore, we selected 10 years as a cut-off point. All Junior surgeons performed PD with scrubbed attending surgeons as a first assistant. We retrospectively assessed clinicopathological variables and disease-free, as well as overall survival, between the Junior and Senior surgeons groups by univariate analysis. Clinicopathological variables consisted of the following factors: age, gender, body mass index (BMI), coexistent diseases, pathological diagnosis, duration of operation, intraoperative blood loss, portal vein reconstruction, intraoperative blood transfusion, texture of the remnant pancreas, in-hospital mortality, postoperative complications and postoperative hospital stay.

Pancreatic fistula and biliary fistula were defined according the International Study Group of Pancreatic Fistula criteria and the International Study Group of Pancreatic Surgery criteria, respectively (12, 13). Pulmonary complications were defined as postoperative pneumonia; postoperative respiratory failure with pyrexia, dyspenia and a pulmonary infiltrate on chest X-ray; or pleural effusion that required thoracentesis. Surgical site infection (SSI) was defined as surgical wound infection with purulent discharge and bacterial isolation or abdominal abscess with pyrexia. Recurrence of pancreatic or biliary malignancies were defined as newly-detected local or distant metastatic tumors by ultrasonogaphy, computed tomography (CT) or magnetic resonance imaging with or without increase in serum carcinoembryonic antigen (CEA) or carbohydrate antigen 19-9 (CA 19-9).

All excised specimens were diagnosed at the Department of Pathology, Jikei University Hospital, Tokyo, Japan. The detailed pathological factors were based on the General Rules for the Study of Pancreatic Cancer by the Japan Pancreas Society (14) and the Classification of Biliary Tract Carcinoma, second English edition by Japan Society of Biliary Surgery (15).

Statistical analysis. The categorical variables were expressed as the number and the percentage (%), while the continuous variables as a mean±standard deviation (SD). Univariate analysis was performed

Figure 1. *Correlation between the post-graduate year and duration of operation. There was a significantly inverse correlation between post-graduate year and duration of operation.*

using the non-paired Student's *t*-test, Pearson's Chi-square test or Fisher's exact test. Analysis of disease-free and overall survival was performed using the log-rank test. Correlation coefficient was analyzed using regression analysis with Pearson's product-moment correlation coefficient. All *p*-values were considered statistically significant when the associated probability was less than 0.05.

Results

Univariate analysis of surgeons' and patients' characteristics. Table I lists the relationship of surgeons' and patients' characteristics between the two groups by univariate analysis. The ratio of patients with diabetes mellitus and cardiac disease as coexistent disease in Senior surgeons group tended to be greater than those in Junior surgeons group, which, however, failed to achieve statistically significant differences (p=0.127 and p=0.114, respectively). Other variables were comparable between the two groups.

Intraoperative outcomes and pathological findings in pancreatic and biliary cancer. Table II lists the relationship of intraoperative variables and pathological findings between the two groups by univariate analysis. Duration of operation in Junior surgeons group was significantly greater than that in Senior surgeons group (p<0.001). Moreover, there was a significant inverse correlation between the post-graduate year and duration of operation (p=0.001, |r|=0.21, Figure 1). Intraoperative blood loss in Junior surgeons group tended to be greater than those in Senior surgeons group, which, however, failed to achieve significant difference (p=0.079). Tumor stage and curability based on pathology in both pancreatic and biliary cancer were comparable between the two groups.

Table III. *Postoperative complication and hospital stay.*

	Junior group (STY≤10; n=60)	Senior group (STY>10; n=193)	*p*-Value
In-hospital mortality, n (%)	0 (0)	3 (2)	0.442
Reoperation, n (%)	0 (0)	4 (2)	0.336
Postoperative hospital stay, days	30.2±15.6*	29.2±30.4	0.803
Complications			
Overall complications, n (%)	30 (50)	91 (47)	0.700
Surgical site infection, n (%)	11 (18)	40 (21)	0.687
Pancreatic fistula (grade B or C), n (%)	10 (17)	35 (18)	0.795
Intra-abdominal bleeding, n (%)	2 (3)	3 (2)	0.340
Intra-abdominal abscess, n (%)	5 (8)	19 (10)	0.727
Bile leakage, n (%)	2 (3)	4 (2)	0.436
Pulmonary complications, n (%)	11 (18)	24 (12)	0.248
Anastomotic leakage, n (%)	2 (3)	2 (1)	0.239
Cerebrovascular event, n (%)	1 (2)	1 (1)	0.419
Delirium, n (%)	1 (2)	2 (1)	0.558

STY, Surgical training year; n; number of patients; *mean±SD.

Postoperative complication and hospital stay. Table III lists the comparison of postoperative short-term outcomes between the two groups by univariate analysis. Although Senior surgeons group had 3 in-hospital mortalities (2%) and 4 reoperations (2%), there was no in-hospital mortality or reoperation in Junior surgeons group. The incidences of postoperative complications and postoperative hospital stay were comparable between the two groups.

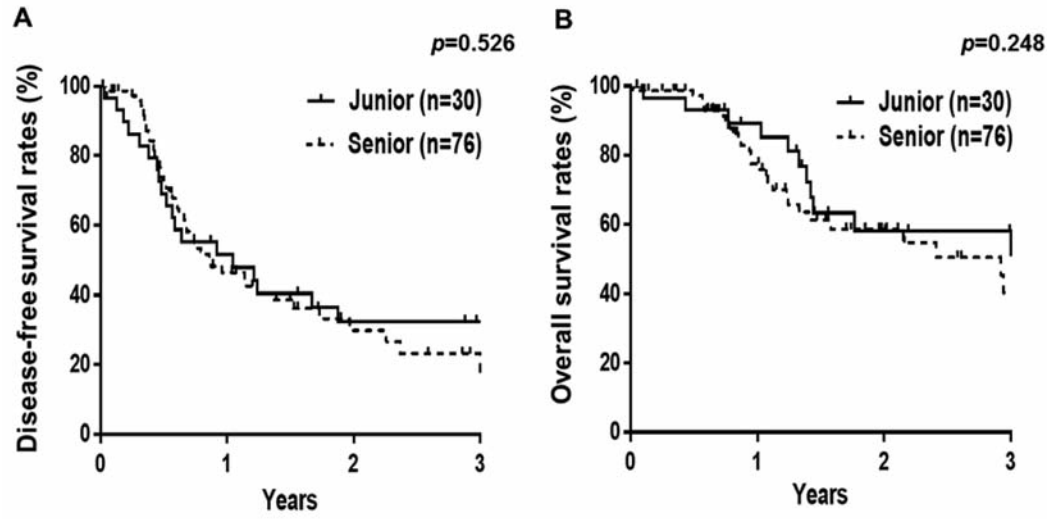

Figure 2. *Disease-free (A) and overall survival (B) were comparable in patients with pancreatic cancer who underwent pancreaticoduodenectomy by Junior surgeons, under appropriate supervision by attending surgeons, and those performed by Senior surgeons.*

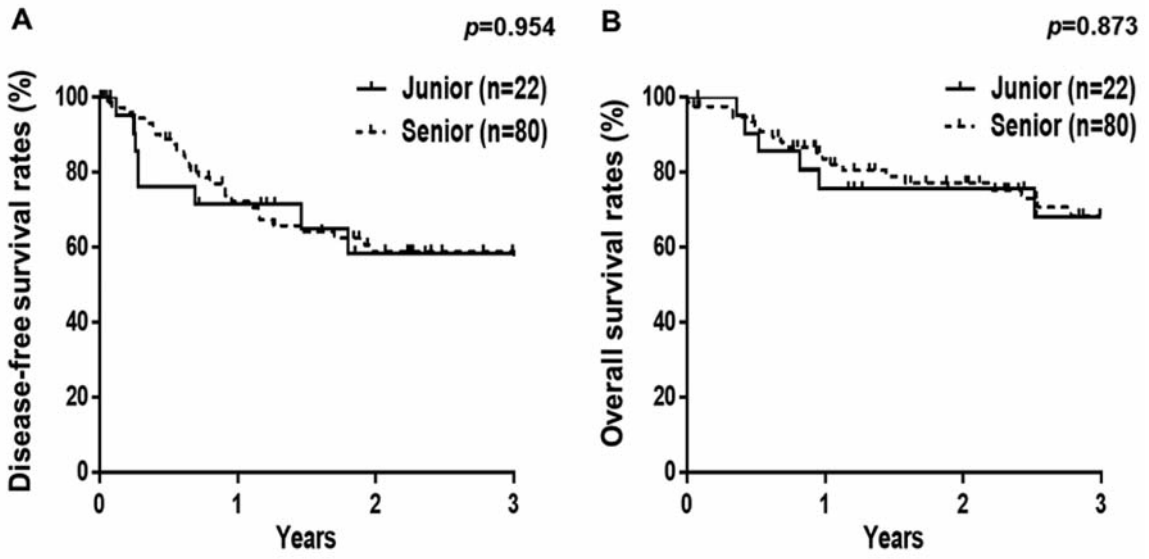

Figure 3. *Disease-free (A) and overall survival (B) were comparable for patients with biliary cancer who underwent pancreaticoduodenectomy by Junior surgeons, under appropriate supervision by attending surgeons, and those performed by Senior surgeons.*

Disease-free and overall survival. Figure 2 shows the Kaplan-Meier curves of disease-free (Figure 2A) and overall survival (Figure 2B) after PD for patients with pancreatic cancer. The disease-free 1- and 3-year survival rates were 52% and 32% in Junior surgeons group and 47% and 23% in Senior surgeons group, respectively (p=0.526). The overall 1- and 3-year survival rates were 89% and 58% in Junior surgeons group and 78% and 40% in Senior surgeons group, respectively (p=0.248). Figure 3 depicts the Kaplan-Meier curves of disease-free (Figure 3A) and overall survival (Figure 3B) after PD for patients with biliary cancer. The disease-free 1- and 3-year survival rates were 71% and 58% in Junior surgeons group and 71% and 58% in Senior surgeons group, respectively (p=0.954). The overall 1- and 3-year survival rates were 76% and 68% in Junior surgeons group and 84% and 69% in Senior surgeons group, respectively (p=0.873).

Discussion

In this study, disease-free and overall survival were comparable between junior and senior surgeon groups in both pancreatic and biliary cancer after PD. Fisher *et al*. (2) described that operator surgeons' experience was not associated with overall survival of the patients with pancreatic cancer after PD. To the best of our knowledge, this is the first report of comparing an equivalent outcome after PD in case of biliary cancer operated by junior surgeons under appropriate supervision by scrubbed attending surgeons with those by senior surgeons.

Surgical experience has already been indicated to correlate with outcomes in complex procedures, such as PD. Birkmeyer *et al*. (6) demonstrated that in-hospital mortality rates after PD at low-volume hospitals were 4-fold that of high-volume hospitals (16% *versus* 4%, $p<0.001$). In addition, the 10 hospitals with the highest volumes in the US had 2.1% in-hospital mortality rates (6). Furthermore, individual surgeons' experience is strongly associated with reduced mortality rates in pancreatic resection (9). Fisher *et al*. (2) showed the surgeons experience correlated with better outcomes, including intraoperative blood loss, transfusion rates, incidences of postoperative complications, postoperative hospital stay and achievement of margin-negative resection. Hardacre compared surgical outcomes between the initial 30 PDs and next 30 cases performed by a single surgeon and reported that the second 30 cases were associated with shorter operation time (16). Schmidt *et al*. compared outcomes between the initial 50 and the next 50 cases, with the second 50 cases taking less operation time and estimated blood loss (17). Tseng *et al*. compared outcomes between the initial and the next 60 cases, with the second 60 cases taking less operation time, estimated blood loss and length of stay, as well as high rate of margin-negative resection (10). Furthermore, learning curve of estimate blood loss, operation time and length of stay continued for over 300 cases (10). However, considering rapid advances of surgical techniques, devices, perioperative patients' management and chemotherapy, comparison between therapeutic outcomes of PD by Junior surgeons and those performed by Senior surgeons seem to be important to assess the safety of PD by Junior surgeons in the same period.

Kazaure *et al*. (18) reported that resident surgeons with scrubbed attending surgeons in the operating room had less complications in appendectomy, cholecystectomy and inguinal hernia repair (4.4% *versus* 4.8%, $p<0.001$) and less operating time (62.2 min *versus* 64.4 min, $p<0.001$), as well as length of stay (18.9% *versus* 20.9%, $p<0.001$) compared to that of residents alone. Mehall *et al*. (19) also described that resident surgeons with attending surgeons in the operating room in laparoscopic colectomy could have same incidence of conversion to an open procedure, complications and length of stay as compared to those operated by attending surgeons. Complex procedures by Junior surgeons greatly receive the influence of supervision by attending surgeons and, therefore, assessment by supervisors may be useful to improve surgical training of Junior surgeons.

In order to achieve acceptable outcome of complex procedures by Junior surgeons, appropriate preoperative assessment of patients' radiological findings and physical status, as well as appropriate assignment of Junior and Senior surgeons as operators, are important. Preoperative assessment of CT is important in predicting postoperative pancreatic fistula after PD (20, 21). Several reports have described that coexistent coronary artery disease and diabetes mellitus are associated with poor surgical outcomes (22, 23). For further improvement of surgical training of Junior surgeons, while securing the quality of operation in such a complex procedure, development of stratification of difficulty of the procedure by further assessments of risks for postoperative complication and poor prognosis seems necessary.

Conclusion

Outcome of PD by Junior surgeons under appropriate supervision by scrubbed attending surgeons as a first assistant is similar to that performed by Senior surgeons with acceptable incidence of postoperative complications, in-hospital mortality and disease-free, as well as overall, survival.

Conflicts of Interest

All Authors have no conflict of interest to declare.

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