Asian Journal of Surgery 45 (2022) 837–843

Contents lists available at ScienceDirect

Asian Journal of Surgery

journal homepage: www.e-asianjournalsurgery.com

Safety and feasibility of laparoscopic pancreaticoduodenectomy in octogenarians

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ARTICLE INFO

Article history:
Received 8 September 2021
Received in revised form
27 September 2021
Accepted 30 September 2021
Available online 12 October 2021

Keywords:
Pancreaticoduodenectomy
Octogenarian
Periampullary tumor
Laparoscopy

ABSTRACT

Introduction: With continued technical advances in surgical instruments and growing surgical expertise, many laparoscopic pancreaticoduodenectomies (LPDs) have been safely performed with favorable outcomes, and this approach is being used more frequently. With an increase in the life expectancy, interest in treatments for elderly patients has increased. In this study, we investigated the safety and feasibility of LPD in octogenarians.

Methods: From September 2005 to February 2020, resectable/borderline resectable periampullary tumors (PATs) were diagnosed in 71 octogenarians at Sincheon Severance Hospital and CHA Bundang Medical Center. Patients were divided into two groups: those who underwent surgery (PD, N = 38) and those who did not (NPD, N = 33). The group that underwent surgery was further divided into two groups: those who underwent open PD (OPD, N = 19), and those who underwent LPD (LPD, N = 19). Perioperative outcomes, including long-term survival, were retrospectively compared between these groups.

Results: There was no significant difference in age, sex, comorbidities, diagnosis, and chemoradiotherapy between the surgery and non-surgery groups. The PD group had a better survival rate than the NPD group ($p < 0.05$). The baseline characteristics and postoperative outcomes were not significantly different between the OPD and LPD groups. Only three and two patients in the OPD and LPD groups had a biochemical leak ($p > 0.999$). There was no significant difference in overall survival and disease-free survival between the OPD and LPD groups ($p = 0.816$, $p = 0.446$, respectively).

Conclusions: LPD is a good alternative for octogenarians with PAT requiring PD.

1. Introduction

The Organization for Economic Cooperation and Development Health Statistics 2019 reported that the global average population life expectancy is 80.7 years.[1] The proportion of octogenarians is rapidly increasing among the elderly population in the United States and in Korea.[2] It is projected that, by 2050, octogenarians will account for 5% of the overall population of the United States.[3] As life expectancy increases, so does the demand for better quality of life and care for elderly patients.[4] In the past, older patients over the age of 80 years used to often refuse surgery after being diagnosed with periampullary tumors (PATs); however, with the advancement of surgical technology and improvement of post-surgical management, elderly patients now have a wide range of options.

PATs are a heterogeneous group of tumors arising from the head of the pancreas, distal common bile duct, and duodenum, including the ampulla of Vater.[5] Pancreaticoduodenectomy (PD) remains the

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https://doi.org/10.1016/j.asjsur.2021.09.021

standard surgical treatment for PATs. The age of patients undergoing PD is increasing with the increase in the number of elderly patients.[6] Nevertheless, the underlying potential comorbidities should be considered while deciding the method of surgical intervention.

The usefulness and stability of open PDs (OPDs) in elderly patients has been demonstrated in many studies.[7–9] With continued technical advances in surgical instruments and growing surgical expertise, many laparoscopic PDs (LPDs) have been safely performed with favorable outcomes; consequently, this approach is being used more frequently.[10,11]

Few studies have compared LPD and OPD in elderly patients aged over 70 or 75 years[10,12,13]; however, no study has investigated this comparison in octogenarians with PATs. In this study, we compared the outcomes of OPD and LPD in octogenarians diagnosed with resectable/borderline resectable PATs to evaluate the feasibility, safety, and oncological effectiveness of LPDs.

2. Materials and methods

2.1. Data collection

This retrospective two institution cohort study included analysis of the medical records of patients with resectable/borderline resectable PATs at Sincheon Severance Hospital and CHA Bundang Medical Center from September 2005 to February 2020. Accordingly, 71 octogenarians were identified and included. The patients were divided into two groups, those who underwent surgery (PD group) and those who did not (NPD group) undergo surgery. Among the patients who underwent surgery, only those who received the pylorus-preserving pancreaticoduodenectomy were included in the study because our institution uses a surgical method that preserves the pylorus in most PD patients. The PD group was further divided into two groups, one which comprised patients who underwent OPDs and the other group which comprised those who underwent LPDs (Supplemental data).

Data were collected on patient demographics, operative variables, pathological findings, postoperative outcomes, and survival status of these patients. To assess and communicate a patient's preanesthesia medical comorbidities, the American Society of Anesthesiologists (ASA) classification was used.[14] The POSSUM scoring system was used to predict the morbidity and mortality owing to surgery in elderly patients.[15–17] The POSSUM score was classified into four groups (A-D) according to the previous reports.[17] The postoperative complications were graded according to the Clavien-Dindo classification system (minor complication: grades I-II; major complication: grades III-V).[18] The highest complication grade in each patient was considered the final overall complication grade. Postoperative pancreatic fistula (POPF) was defined according to the updated International Study Group of Pancreatic Fistula criteria established in 2016.[19] Delayed gastric emptying (DGE) was defined as the inability to tolerate oral intake, emesis, and the need for prokinetics or nasogastric tube decompression, with grades A, B, and C based on the presence and duration of each of these factors.[20] The study was approved by the institutional review board of Sincheon Severance Hospital (approval number: 4-2020-0796).

2.2. Statistical analysis

Chi-square test (or Fisher's exact test) and Student's t-test (or Mann–Whitney *U* test) were performed using SPSS 24.0 for Windows (SPSS Inc., Chicago, IL, USA). Continuous variables were tested using the Student's t-test or Mann–Whitney *U* test. Categorical variables were tested using the chi-square or Fisher's exact test. Data of continuous variables were expressed as mean ± standard deviation (SD), whereas data of categorical variables were expressed as numbers (percentages). The Cox proportional hazards regression model was used for univariate and multivariate analyses. Significant variables on univariate analysis underwent multivariable analysis. Statistical significance was defined as $p < 0.05$. Median survival was estimated using the Kaplan–Meier method.

3. Results

3.1. Baseline characteristics of all patients

Table 1 shows the clinicopathological characteristics of all patients. A total of 71 patients were divided into the NPD (N = 33) and PD groups (N = 38). Patients in the NPD group were older than those in the PD group ($p = 0.003$). The NPD group had more male patients while the PD group had more female patients ($p = 0.046$). There was no significant difference between the two groups in body mass index (BMI), preoperative carcinoembryonic antigen (CEA), preoperative carbohydrate antigen 19–9 (CA19-9), and tumor location (Table 1). Regarding comorbidities, the PD group had more patients with diabetes mellitus (DM) than the NPD group ($p = 0.040$). There was no significant difference between the two groups with regard to hypertension (HTN), coronary artery occlusive disease (CAOD), and cerebrovascular accident (CVA). The PD group had more patients with ASA score 3 (NPD vs. PD: 33.3% vs. 68.4%, $p = 0.004$), whereas the NPD group had more patients with ASA score 2 (NPD vs. PD: 66.7% vs. 28.9%, $p = 0.002$). There were no patients with ASA score 1 in either of the groups. The PD group had more patients with POSSUM score C (NPD vs. PD: 18.2% vs. 73.7%, $p < 0.0001$), whereas the NPD group had more patients with POSSUM score B (NPD vs. PD: 78.8% vs. 18.4%, $p < 0.0001$). Fig. 1 shows the reasons for refusal of surgery in NPD. The most common reason for refusal of surgery in NPD was refusal of the guardians (43%).

3.2. Prognostic factors in overall survival

Table 2 shows the prognostic factors in overall survival. Among those variables, age [*Hazard Ratio (HR): 1.114, 95% Confidence Interval (95% CI): 1.012-1.226, p* = 0.028*], POSSUM score (*HR: 0.230, 95% CI: 0.098-0.539, p* = 0.001*), surgery (*HR: 0.059, 95% CI: 0.018-0.198, p* < 0.0001*), and surgical method (*HR: 0.060, 95% CI: 0.014-0.259, p* < 0.0001*) were the prognostic factors in overall survival in univariate analysis*. Surgery was the only prognostic factor in overall survival in multivariate analysis** (*HR: 0.031, 95% CI: 0.003-0.277, p** = 0.002*).

3.3. Baseline characteristics of the patients by surgical method (LPD vs. OPD)

Table 3 shows the baseline characteristics of the patients using the surgical method. The PD group was divided into two groups: those who underwent OPDs (N = 19) and those who underwent LPDs (N = 19). Table 3 lists the baseline characteristics of the patients according to the surgical method. There was no significant difference in age, sex, BMI, comorbidities (HTN, DM, CAOD, and CVA), ASA score, POSSUM score, tumor location, pancreatic duct size and pancreas texture, and adjuvant chemotherapy between the LPD and OPD groups. There was no mortality at 90 days after surgery.

Table 1
Patients' clinicopathological characteristics.

Variables	Number of patients (N = 71)	NPD (N = 33)	PD (N = 38)	*P value*
Age, years, mean±SD	82 ± 2.93	83.61 ± 3.73	81.39 ± 1.37	0.003
Sex (M:F), n (%)	34 (47.9):37 (52.1)	20 (60.6):13 (39.4)	14 (36.8):24 (63.2)	0.046
BMI, kg/m,^{2} mean±SD	22.89 ± 3.05	22.52 ± 2.99	23.20 ± 3.11	0.353
Comorbidity, n (%)				>0.999
HTN	48 (67.6)	20 (60.6)	28 (73.7)	0.311
DM	22 (31.0)	6 (18.2)	16 (42.1)	0.040
CAOD	3 (4.2)	1 (3.0)	2 (5.3)	>0.999
CVA	8 (11.3)	5 (15.2)	3 (7.9)	0.459
ASA score, n (%)				0.003
1	0	0	0	
2	33 (46.5)	22(66.7)	11 (28.9)	0.002
3	37 (52.1)	11(33.3)	26 (68.4)	0.004
4	1 (1.4)	0	1 (2.6)	1
POSSUM score[a], n(%)				<000.1
A (0–4%)	0	0	0	
B (5–14%)	33 (46.5)	26 (78.8)	7 (18.4)	<000.1
C (15–49%)	34 (47.9)	6 (18.2)	28 (73.7)	<000.1
D (50% or more)	4 (5.6)	1 (3.0)	3 (7.9)	0.618
CEA, ng/mL, mean±SD	3.40 ± 3.67	4.05 ± 4.63	2.84 ± 2.51	0.187
CA19–9, U/mL, mean±SD	505.07 ± 1312.44	496.24 ± 863.06	512.74 ± 1616.92	0.890
Tumor location, n (%)				0.274
CBD	29 (40.8)	13 (39.4)	16 (42.1)	>0.999
Pancreas	21 (29.6)	7 (21.2)	14 (36.8)	0.196
AoV	16 (22.5)	10 (30.3)	6 (15.8)	0.166
Duodenum	5 (7.0)	3 (9.1)	2 (5.3)	0.658
Resectability, n (%)				>0.999
Resectable	70 (98.6)	33 (100)	37 (97.4)	
Borderline	1 1(0.4)	0	1 (2.6)	
Surgery, n (%)				>0.999
No surgery	33 (46.4)	33 (100)	0	
Open surgery	19 (26.8)	0	19 (50)	
Laparoscopic	19 (26.8)	0	19 (50)	
Chemotherapy, n (%)	13 (18.3)			>0.999
Palliative		4 (12.1)	0	
Adjuvant		0	9 (23.7)	

BMI, body mass index; HTN, hypertension; DM, diabetes mellitus; CAOD, carotid artery occlusive disease; CVA, cerebrovascular accident; CBD, common bile duct; AoV, ampulla of Vater; CEA, carcinoembryonic antigen, CA, carbohydrate antigen, NPD, non-pancreaticoduodenectomy; PD, pancreaticoduodenectomy; SD, standard deviation.
[a] POSSUM score was classified four group (A-D) according to the previous reports.

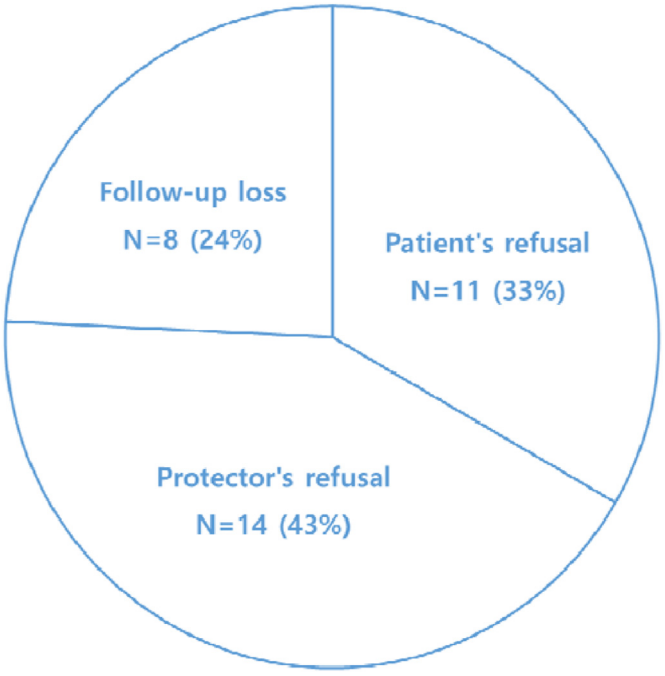

Fig. 1. Reasons for refusal of surgery in NPD
NPD, non-pancreaticoduodenectomy.

3.4. Comparison between OPD and LPD in postoperative complications

Table 4 shows postoperative complications according to the surgical method. There was no significant difference in postoperative complications between the two groups. Most patients had no POPF in either group (78.9% vs. 78.9%, $p > 0.999$). Only three patients of OPD and two patients of LPD groups, respectively, had a biochemical leak ($p > 0.999$). One patient in the LPD group had a Grade C POPF ($p > 0.999$), and one patient in the OPD group and two patients in the LPD group had a major complication (≥Grade III, $p > 0.999$). The other postoperative complications were not significantly different between the two groups.

One major complication of the OPD group was postoperative acute kidney injury, which was treated in the intensive care unit. There were two cases of major complications in the LPD group. One patient had a drainage catheter with POPF grade B and the other who had POPF grade C was treated in an intensive care unit for postoperative bleeding. The operation time in the LPD group was longer than that in the OPD group (338 ± 53.01 vs. 441 ± 61.87 min, $p < 0.0001$). The amount of intraoperative blood loss was not significantly different between the OPD and LPD groups ($p = 0.102$). There was no significant difference in the length of hospital stay between the two groups ($p = 0.885$).

Table 2
Prognostic factors in overall survival.

Variables	Univariate Analysis			Multivariate Analysis		
	HR	95% CI	P[a]	HR	95% CI	P[b]
Age	1.114	1.012–1.226	0.028	0.958	0.850–1.079	0.477
Sex						
M vs. F	0.823	0.404–1.676	0.592	1.535	0.695–3.390	0.290
ASA score						
2 vs. 3	0.459	0.210–1.002	0.051	1.057	0.340–3.290	0.923
POSSUM score						
<15 vs. ≥15	0.230	0.098–0.539	0.001	1.761	0.454–6.831	0.414
Surgery						
No vs. Yes	0.059	0.018–0.198	<0.0001	0.031	0.003–0.277	0.002
Surgical method						
Open vs. Lap	0.060	0.014–0.259	<0.0001	0.991	0.086–11.448	0.994
Chemotherapy						
No vs. Yes	0.691	0.241–1.979	0.491	1.202	0.385–3.750	0.751

M male, *F* female, *CEA* carcinoembryonic antigen, *CA* carbohydrate antigen.
[a] Univariate analysis.
[b] Multivariate analysis.

Table 3
Patients' baseline characteristics by surgical method.

Variables	OPD (n = 19)	LPD (n = 19)	*P value*
Age, years, mean±SD	81 ± 1.07	81 ± 1.64	0.729
Sex (M:F), n (%)	7:12 (36.8:63.2)	7:12 (36.8:63.2)	>0.999
BMI, kg/m,[2] mean±SD	23.24 ± 3.14	23.17 ± 3.17	>0.999
Comorbidity, n (%)			
HTN	13 (68.4)	15 (78.9)	0.461
DM	7 (36.8)	9 (47.4)	0.511
CAOD	2 (10.5)	0 (0)	0.486
CVA	0 (0)	3 (15.8)	0.230
ASA score, n (%)			0.728
1	0 (0)	0 (0)	
2	6 (31.6)	5 (26.3)	>0.999
3	12 (63.2)	14 (73.7)	0.728
4	1 (5.3)	0 (0)	1
POSSUM score, n(%)			0.539
A	0		
B	2 (10.5)	5 (26.3)	0.405
C	15 (78.9)	13 (68.4)	0.714
D	2 (10.5)	1 (5.3)	>0.999
Tumor location, n (%)			>0.999
CBD	5 (26.3)	11 (57.9)	0.099
Pancreas	11 (57.9)	4 (21.1)	0.091
AoV	2 (10.5)	3 (15.8)	>0.999
Duodenum	1 (5.3)	1 (5.3)	>0.999
PD size, mm, mean±SD	4.25 ± 2.94	4.16 ± 3.02	0.935
Pancreas texture, n (%)			0.391
Soft	10 (76.9)	13 (72.2)	0.508
Intermediate	1 (7.7)	0 (0)	>0.999
Hard	2 (15.4)	5 (27.8)	0.405
Adjuvant chemotherapy, n (%)	5 (26.3)	4 (21.1)	>0.999
Ninety-day mortality	0	0	

BMI, body mass index; HTN, hypertension; DM, diabetes mellitus; CAOD, carotid artery occlusive disease; CVA, cerebrovascular accident; CBD, common bile duct; AoV, ampulla of Vater; PD, pancreatic duct; OPD, open pancreaticoduodenectomy; LPD, laparoscopic pancreaticoduodenectomy; SD, standard deviation.

3.5. Comparison of short-term oncological outcomes between OPD and LPD

Table 5 shows oncological outcomes according to the surgical method. There was no significant difference in the diagnosis ($p = 0.116$). There was no significant difference in cell differentiation; positive lymph node (LN), retrieved LN, and resection (R) status; perineural invasion; and lymphovascular invasion.

3.6. Improved survival in octogenarians who underwent pancreaticoduodenectomy

Fig. 2 shows the Kaplan–Meier survival curve of overall survival (OS) (NPD vs. PD). The PD group had a better survival rate than the NPD group ($p < 0.05$). The mean survival of the NPD group was 11.91 ± 1.29 months (95% CI: 9.38–14.45), and the mean survival of the PD group was 43.04 ± 6.54 months (95% CI: 30.21–55.86).

3.7. No significant difference in survival and recurrence between LPD and OPD

Figs. 3 and 4 show the Kaplan–Meier survival curves of OS and disease-free survival (DFS) (OPD vs. LPD). There was no significant difference between the OPD and LPD groups in the Kaplan–Meier survival curves of OS and DFS ($p = 0.816$, $p = 0.446$). The mean survival of the LPD group was 43.00 ± 6.96 months (95% CI: 29.37–56.64), and the mean survival of the OPD group was 31.47 ± 2.92 months (95% CI: 25.76–37.19).

4. Discussion

With increasing patient age, there is an increase in the number of older patients with PATs undergoing PD.[21,22] In the past, age over 80 years was considered a risk factor; hence, these patients would avoid surgery. However, with improvement in the quality of life and advances in health examination techniques, treatments, and patient management, the numbers of healthy elderly patients are increasing. Therefore, we now need to reconsider whether such procedures are a contraindication for patients based on age alone.

Few studies have compared LPD and OPD in elderly patients aged over 70 or 75 years.[10,12,13] Shin et al reported a study comparing LPD and OPD in elderly patients over 70 years of age using propensity-score matching analysis. There was no significant difference in the three-year OS and DFS rates between the LPD and OPD groups (OS: 68.8% vs. 83.2%, $p = 0.383$; DFS: 53.3% vs. 65.6%, $p = 0.71$).[13] Chapman et al reported that the median OS was significantly longer in the LPD group aged over 75 years (19.8 vs. 15.6 months, $p = 0.022$).[10] However, there are no reports comparing LPD and OPD in octogenarians.

In this study, it was successfully demonstrated that

Table 4
Postoperative complications by surgical method.

Variables	OPD (n = 19)	LPD (n = 19)	*P value*
POPF, n (%)			>0.999
No POPF	15 (78.9)	15 (78.9)	>0.999
Biochemical leak	3 (15.8)	2 (10.5)	>0.999
Grade B	1 (5.3)	1 (5.3)	>0.999
Grade C	0 (0)	1 (5.3)	>0.999
Biliary leak, n (%)	1 (5.3)	0 (0)	>0.999
DGE, n (%)	2 (10.5)	2 (10.5)	>0.999
Bleeding, n (%)	1 (5.3)	1 (5.3)	>0.999
Abscess, n (%)	1 (5.3)	0 (0)	>0.999
Ascites, n (%)	1 (5.3)	0 (0)	>0.999
Wound, n (%)	1 (5.3)	1 (5.3)	>0.999
Major complication, n (%) (≥C-D grade III)	1 (5.3)	2 (10.5)	>0.999
Operation time, min, mean±SD	338 ± 53.01	441 ± 61.87	<0.0001
Intraoperative blood loss, ml, mean±SD	518 ± 461.45	325 ± 198.78	0.102
Intraoperative transfusion, n (%)	1 (5.3)	1 (5.3)	>0.999
Hospital stay, days, mean±SD	27 ± 19.58	28 ± 18.81	0.885

POPF, postoperative pancreatic fistula; DGE, delayed gastric emptying; C-D grade, Clavien-Dindo classification system; OPD, open pancreaticoduodenectomy; LPD, laparoscopic pancreaticoduodenectomy; SD, standard deviation.

Table 5
Oncological outcomes by surgical method.

Variables	OPD (n = 19)	LPD (n = 19)	*P value*
Diagnosis, n (%)			0.116
PDAC	6 (31.6)	2 (10.5)	0.232
IPMN	5 (26.3)	1 (5.3)	0.180
NET	0 (0)	1 (5.3)	1
AoV cancer	2 (10.5)	3 (15.8)	>0.999
CBD cancer	5 (26.3)	11 (57.9)	0.099
Duodenal cancer	1 (5.3)	1 (5.3)	>0.999
Cell differentiation, n (%)			0.277
Well	4 (21.1)	0 (0)	1
Moderate	10 (52.6)	13 (68.4)	0.508
Poorly	2 (10.5)	2 (10.5)	>0.999
Unknown	3 (15.8)	4 (21.1)	>0.999
Positive LN, n (%)	0[0–2]	0[0–2]	0.893
Retrieved LN, n (%)	10[7–18]	10.5[6–16]	0.730
R status, n (%)			>0.999
R0	16 (84.2)	16 (84.2)	
R1	3 (15.8)	3 (15.8)	
Perineural invasion, n (%)			0.800
No	6 (31.6)	6 (27.8)	
Yes	13 (68.4)	13 (72.2)	
Lymphovascular invasion, n (%)			0.800
No	13 (68.4)	13 (72.2)	
Yes	6 (31.6)	6 (27.8)	

PDAC, pancreatic ductal adenocarcinoma; IPMN, intraductal papillary mucinous neoplasm; NET, neuroendocrine tumor; AoV, ampulla of Vater; CBD, common bile duct; OS, overall survival; DFS, disease-free survival; LN, lymph node; OPD, open pancreaticoduodenectomy; LPD, laparoscopic pancreaticoduodenectomy; R, residual tumor.

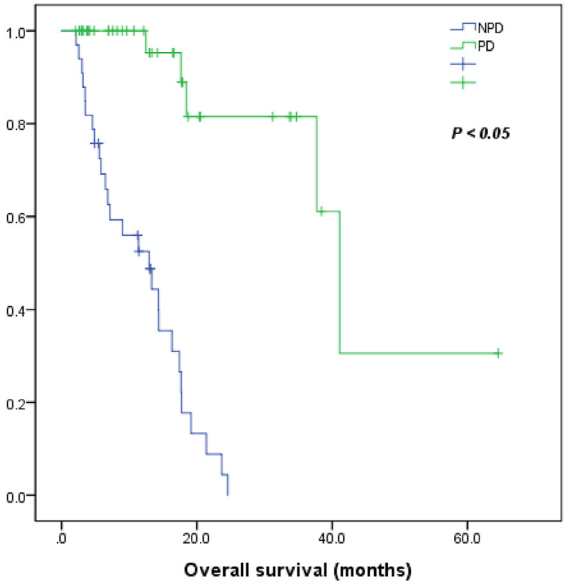

Fig. 2. Kaplan–Meier survival curve of overall survival (NPD vs. PD)
NPD, non-pancreaticoduodenectomy; PD, pancreaticoduodenectomy.

octogenarians who underwent surgery had better prognosis than those who did not undergo surgery, although there was no significant difference in the clinicopathological characteristics between the two groups. In both the PD and NPD groups, not many patients received additional treatment; a possible explanation for this could be that the burden of chemotherapy in elderly patients was high; hence, there were not many cases of chemotherapy observed in the groups.

Guardians of octogenarians often refuse to undergo surgery in consideration of the patient's age. In the past, the quality of life of elderly patients was low, dependence on protectors was high, and life expectancy was not high. However, as the average life expectancy has increased and the quality of life has improved in recent years, the number of independent and healthy elderly patients among octogenarians is increasing. Octogenarians often want to undergo surgery on their own. In this data, it is believed that this is why the NPD group has many low ASA and POSSUM scores. The number of patients in the PD group has increased relatively recently, and despite the high ASA and POSSUM scores, the number of patients undergoing surgery has increased owing to the patient's high degree of willingness for surgery.

One of the major reasons for reluctance of elderly patients to undergo surgery is the concern for potential postoperative complications, challenges of recovery, and short life expectancy. However, several studies have reported that there is no difference in the risk of complications or prognosis between the elderly and young patients.[23–25] Beltrame et al reported that complication rates (young vs. elderly; 40% vs. 43%) and overall median survival (young vs. elderly; 21 vs. 19 months) were not significantly different between the elderly (≥80 years old) and young (<80 years old) patients ($p = 0.86$).[24]

In the past, open surgery was of choice when performing surgery in elderly patients. Most of the elderly patients had to undergo open surgery since it reduced the operation time and amount of

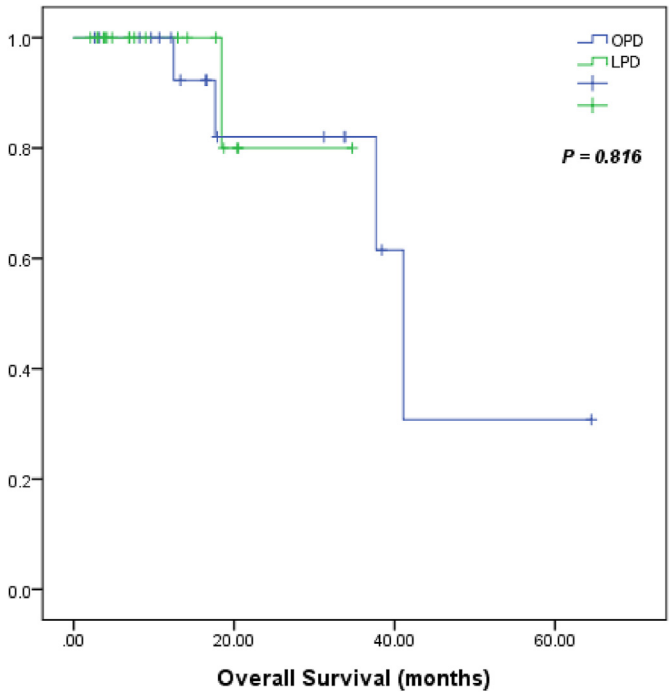

Fig. 3. Kaplan–Meier survival curve of overall survival (OPD vs. LPD)
OPD, open pancreaticoduodenectomy; LPD, laparoscopic pancreaticoduodenectomy.

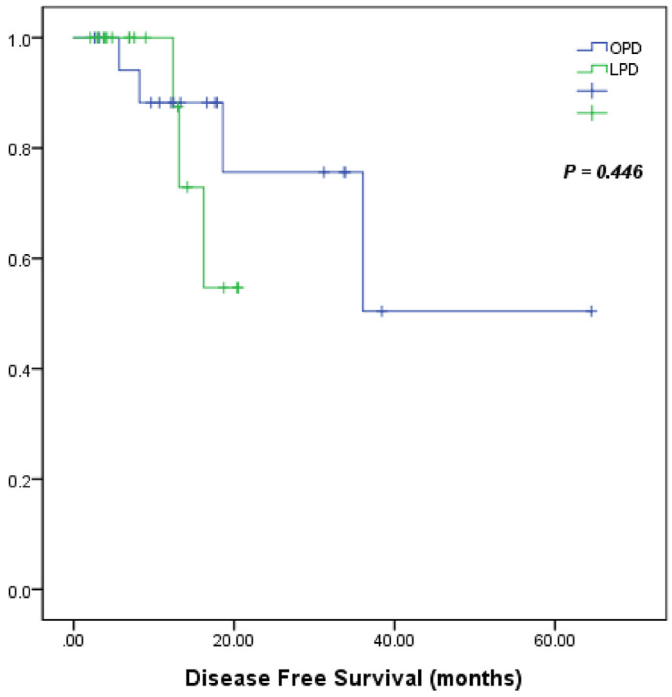

Fig. 4. Kaplan–Meier survival curve of disease-free survival (OPD vs. LPD)
OPD, open pancreaticoduodenectomy; LPD, laparoscopic pancreaticoduodenectomy.

blood loss. It also helped to perform the operation efficiently. However, with the advancement of technology and the increased number of skilled laparoscopic surgeons, LPD procedures are safer with lesser operation time and amount of blood loss than OPD.[12,13] Further, LPD resulted in less severe wounds and lesser pain after surgery than OPD.[26,27] Therefore, LPD can be good for pain relief and rapid recovery after surgery in elderly patients. This information calls for a change in the perspective of open and laparoscopic surgeries in elderly patients.

In our study, although the patients in the NPD group were relatively younger than those in the PD group, the latter were considered to have a higher risk with high ASA and POSSUM scores. One patient showed Grade C POPF in the LPD group. A patient treated in the intensive care unit recovered from multiple organ failure after hemostasis and embolization by duodenoejunostomy site bleeding and central pancreatic artery bleeding after LPD following CBD cancer. And the operation time was relatively long and there were more cases with complications in the LPD group than the OPD group. Because LDP contains more initial experience of the operator than OPD.

This study has several considerable limitations owing to its retrospective design. Because LPD in elderly patients was introduced relatively recently; there was no choice but to compare a small group of patients. Although data from two institutions were analyzed to compensate for the small number of patients, the samples were not large enough. In the future, LPD will be applied to more patients, and it is expected that further studies will include larger patient cohorts. Since the sample size in this study was small, the benign and malignant tumors were not distinguished, and there was no significant difference in distribution. If the number of target groups were higher, this would be a good study to compare the prognosis of the two surgical methods by distinguishing between the malignant and benign tumors. Multicenter studies based on more experience and information are hence needed in the future.

5. Conclusions

PD can improve survival outcomes in octogenarian patients with PATs, and LPD is a feasible, safe, and oncologically effective surgical approach even in octogenarians. However, LPD does not appear to have a clear clinical advantage over OPD; therefore, further research in this area is warranted. To this end, it is thought that in operable octogenarians, laparoscopic and open surgery can be properly adjusted for safe PD procedures according to the condition of the patient, desires of the patient or guardian, and the preference of the surgeon.

Declaration of competing interest

Drs. Ji Su Kim, Munseok Choi, Sung Hyun Kim, Sung Hoon Choi, Chang Moo Kang declare no conflict of interest for this article.

Acknowledgements

We would like to thank Editage (www.editage.co.kr) for English language editing.

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