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Distal Pancreatectomy with Celiac Axis Resection for Carcinoma of the Body and Tail of the Pancreas

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Abstract
Background We retrospectively investigated our experiences with distal pancreatectomy with celiac axis resection (DP-CAR) for locally advanced pancreatic cancer and compared the operative outcome and long-term survival between DP-CAR and standard distal pancreatectomy (DP). Although several authors reported that DP-CAR increases resectability rates, the long-term results of this operation are not clear, and there are few reports presenting a comparison of the short- and long-term results between DP-CAR and DP.
Methods From 1993 to 2010, 43 patients with invasive ductal carcinoma of the body or tail of the pancreas underwent a macroscopically curative resection (R0/1). Sixteen patients underwent DP-CAR and 27 patients underwent DP. No DP-CAR patients underwent any preoperative coil embolization of the common hepatic artery (CHA) to stimulate the development of collateral pathways from the superior mesenteric artery. The perioperative and histopathologic parameters and survival data were analyzed to compare the two operations.
Results There was no difference in mean operative time, mean blood loss, postoperative mortality, and morbidity between DP-CAR and DP. The rates of morbidity and in-hospital mortality of DP-CAR were 56 and 6%, respectively. In DP-CAR, 15 patients did not require reconstruction of the hepatic artery and no hepatic infarctions were clinically encountered after surgery. The estimated overall 1- and 3-year survival rates in patients who underwent DP-CAR were 42.6 and 25.6%, respectively, and their survival time was significantly less than that of patients who underwent DP (median survival time: 9.7 vs. 30.9 months, $P = 0.033$). The R1 resection rates of these groups were 44% in DP-CAR and 22% in DP, respectively.
Conclusion DP-CAR is a safe and rational procedure for locally advanced pancreatic cancer without preoperative embolization of the CHA. Although the short-term results were equivalent to that for DP, DP-CAR did not improve the long-term survival because of the high rate of R1 resection at present.

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Introduction

Despite the development of various techniques for the diagnosis of pancreatic disease, adenocarcinoma of the body and tail of the pancreas has historically been considered a disease with a dismal prognosis. Because of the late appearance of symptoms, most patients with cancer of the body or tail of the pancreas present with disease that has already spread outside of the pancreatic parenchyma, from direct invasion of adjacent organs or vascular structures to metastasis to regional lymph nodes and distant organs. Therefore, patients with tumors of the body and tail of the pancreas typically present in a more advanced stage and have a lower resectability rate than those with the more proximal pancreatic cancer [1–5]. However, there is no doubt that surgical resection is the only treatment with the chance for a cure, and distal pancreatectomy (DP), consisting of an extended dissection of the retroperitoneal structures with lymphadenectomy, has been advocated to improve operative results [5–7].

To increase resectability rates, a surgical method for locally advanced pancreatic cancer is necessary. However, locally advanced cancers of the body of the pancreas often involve the CHA and/or celiac axis (CA) and are regarded

as unresectable [8]. In 1953, Appleby proposed en bloc resection of the celiac trunk with DP and total gastrectomy for the treatment of locally advanced gastric cancer. Nimura et al. [9] first adapted this operation to resect tumors of the body and tail of the pancreas in 1976. In recent years, several institutions have reported their experience with the modified Appleby operation, i.e., DP combined with en bloc resection of the CA, which was named DP-CAR by Kondo et al. [9–23]. These reports proved that this procedure can increase the resectability with an acceptable postoperative complication rate and improve overall results. However, the indication for this operation is controversial, and the long-term results are not clear because the numbers included in the study population were too small. A few reports have presented a comparison of the short- and long-term results between the patients who received DP-CAR and those who received DP [17].

Since 1999, we have performed DP-CAR with or without preserving the whole stomach in patients with pancreatic body and tail carcinoma involving the CA and/or CHA. The purpose of this study was to review our experience with DP-CAR and to compare short- and long-term results between DP-CAR and DP.

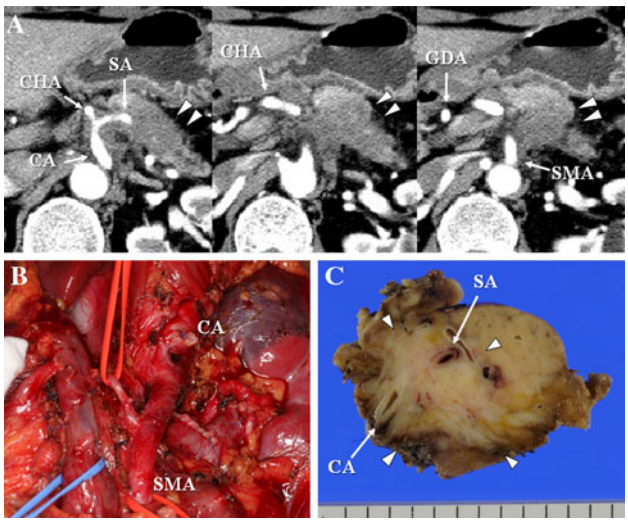

Fig. 1 **a** Contrast-enhanced CT showing a representative case. The celiac axis (CA), common hepatic artery (CHA), and splenic artery (SA) are involved with a tumor of the pancreatic body (*arrowhead*). The gastroduodenal artery (GDA) and supramesenteric artery (SMA) can be preserved. **b** Intraoperative photograph after DP-CAR. **c** Macroscopic findings in the cut specimen. The bifurcation of the CA and SA are involved with a tumor of the pancreatic body (*arrowhead*)

Patients and methods

From July 1993 to March 2010, 304 patients diagnosed with pancreatic cancer were referred to our department of surgery, and 227 patients underwent resection at Ogaki Municipal Hospital. Excluding 164 patients with pancreatoduodenectomy and 2 with total pancreatectomy, DP was performed in 61 consecutive patients, 56 of whom were proven histologically to have invasive ductal carcinoma. Excluding 13 patients (23.2%) with macroscopic residual tumor (R2) or distant metastasis (M1), 43 patients (76.8%) underwent a macroscopically curative resection (R0/1) and made up the study population. The surgical indications in each patient were discussed with their gastroenterologist and radiologist; distant metastases including para-aortic lymph node enlargement or apparent encasement of the superior mesenteric arteries (SMA) were considered contraindications for a curative operation. DP-CAR was indicated in patients who had a cancerous invasion around the CA and the origin of the CHA and/or the splenic artery (SA) (Fig. 1a). No neoadjuvant chemotherapy was utilized in this study. Intraoperative radiation therapy was performed in 8 patients in the 1990s and postoperative adjuvant chemotherapy using gemcitabine [24] or S-1[25] was administered in 11 patients beginning in 2006. After a recurrence was identified, chemotherapy including gemcitabine or S-1 alone or a combination of both drugs was administered in select patients. Because the number of patients who received intraoperative radiation and adjuvant chemotherapy was small, the data related to them were not entered into the analysis.

Surgical procedure

Our principal surgical procedure for invasive ductal carcinoma of the pancreas was an en bloc resection of the proximal or distal pancreas and the contiguously involved structures required to completely extirpate all gross disease [26]. DP was performed using an antegrade approach [27], which consisted of en bloc resection for DP and splenectomy with left adrenalectomy. The neck of the pancreas was transected over the right side of the portal vein (PV). The regional and peripancreatic lymph nodes, including those along the CHA, around the CA, and on the left side of the aorta, were routinely dissected. The left side of the SMA was also dissected with the surrounding lymph node and nerve plexus. The retroperitoneal structures, including the Gerota fascia and left adrenal gland, were routinely removed, even without any apparent invasion to the retropancreatic tissue. If necessary, a combined resection of the surrounding organs, such as the stomach, small intestine, colon, and portal/superior mesenteric vein, was performed to obtain a negative surgical margin.

The specific procedure for DP-CAR was as follows: Before the division of the neck of the pancreas, the bifurcation of the gastroduodenal artery (GDA) and CHA was exposed, followed by exposure of the origin of the proper

hepatic artery (PHA). By dissecting the right celiac ganglion and celiac nerve plexus, the origin of the CA was exposed. Then, blood flow through the PHA, the right gastric artery, and the right gastroepiploic artery was confirmed by palpation, and intrahepatic arterial flow was also checked by intraoperative Doppler ultrasonography after clamping both the root of the CA and the end of the CHA. The CHA was divided just proximal to the origin of the GDA. Lifting up the cut end of the distal pancreas, the SMA was dissected from the surrounding lymph node and nerve plexus toward its origin. Great care was taken to preserve the inferior pancreaticoduodenal artery (IPDA) arising from the SMA or the first jejunal artery. The origin of the CA was identified circumferentially just above the aorta and was divided. No patients underwent any preoperative coil embolization of the CHA to stimulate the development of collateral pathways from the SMA or to prevent postoperative ischemia-related complications [18]. When a distinct extent of the cancerous invasion to the gastric wall or the lesser curvature was found, a combined resection of the total stomach was performed to prevent any postoperative ischemic gastropathy. The status after DP-CAR is shown in Fig. 1b.

Histopathologic evaluation

The specimens were serially sectioned perpendicular to the long axis of the pancreas at 5-mm intervals (Fig. 1c). The surgical margins of the pancreatic stump and retroperitoneal soft tissue, including the celiac ganglion and nerve plexus around the SMA, were evaluated in all the sections. R0 resection was considered in those that lacked any tumor involvement of the margin, whereas R1 resection had a microscopically positive margin on the specimen. Two stage IV patients who underwent DP-CAR unexpectedly presented with histologic para-aortic lymph node metastases and were classified into the R1 resection group in this study. The pathologic findings are described using the TNM Classification of Malignant Tumors by the International Union Against Cancer (6th ed., 2002).

Statistics

The results are expressed as mean ± SD. The statistical analysis was performed using a χ^2 test and Fisher's exact probability test where appropriate. Patient survival was determined from the time of surgery to the time of death or the most recent follow-up. Postoperative survival was calculated using the Kaplan–Meier method. Differences in survival curves were compared using the log-rank test. A multivariate analysis was performed with a logistic regression analysis that had been programmed in the Statistical Package for the Social Science (SPSS) ver. 18.0 software (SPSS, Inc., Chicago, IL). A $P < 0.05$ was considered statistically significant.

Results

A follow-up of the patients, including a clinical evaluation and laboratory tests, was carried out, and adequate survival data were obtained for all 43 patients. The patients consisted of 25 men and 18 women with a mean age of 68 years (range = 50–89). The tumors were located in the pancreatic body in 32 patients (74%). According to the TNM system, the stages of the patients were distributed as follows: IA, 3 patients (7%); IB, 1 patient (2%); IIA, 15 patients (35%); IIB, 15 patients (35%); III, 7 patients (16%); and IV, 2 patients (5%). Overall survival rate in all 43 patients was 66.7, 26.8, and 16.8% at 1, 3, and 5 years, respectively, and the median survival time was 26.7 months. The median follow-up period was 15 months (range = 3–122 months), and two patients (7%) survived for more than 5 years. In contrast, the median survival time in the 13 patients in the R2/M1 resection group was 5.1 months, and the prognosis in those patients was significantly less that for the R0/1 resection group ($P < 0.001$).

Comparison of the operative outcomes between DP-CAR and DP

Sixteen patients in our study cohort underwent DP-CAR, while the remaining 27 patients had DP. The perioperative variables comparing DP-CAR and DP are listed in Table 1. In DP-CAR, the mean operative time was 237 ± 63 min (range = 145–370 min) and the mean blood loss was 702 ± 82 ml (range = 240–1,525 ml). The operative time and the blood loss were greater in the patients who underwent DP-CAR than in those who underwent DP, although they were not significantly different. In DP-CAR, one patient had reconstruction of the hepatic artery because of a cancerous invasion to the GDA. That patient underwent subtotal DP with en bloc resection of the CA, CHA, GDA, PV, bile duct, and total stomach. The PHA was directly anastomosed end-to-end to the mobilized middle colic artery, and a graft reconstruction of the portal system using an autologous vein (the right external iliac vein) was required. Other than this patient, three patients underwent a combined resection of the PV-SMV confluence with end-to-end anastomosis. In seven patients (44%), en bloc resection of the stomach, jejunum, or transverse colon was performed.

The morbidity and postoperative mortality did not significantly differ between the two groups; however, major complications due to the Clavian–Dindo classification [28, 29] were more prevalent in DP-CAR than DP.

Table 1 Comparison of short-term results between DP-CAR and DP

Variable	DP-CAR ($n = 16$)	DP ($n = 27$)	P
Age (years)	65 ± 7	70 ± 9	0.036
Gender (female/male)	8/8	10/17	0.526
Operative time (min)	237 ± 63	203 ± 83	0.233
Blood loss (g)	702 ± 82	634 ± 85	0.505
Reconstruction of hepatic artery	1 (6)	0	0.372
Portal vein resection	4 (25)	4 (15)	0.443
Other resected organs	7 (44)	7 (26)	0.316
Stomach	7	6	
Small intestine	1	2	
Colon	1	6	
Left kidney	0	1	
Bile duct	1	0	
Morbidity	9 (56)	12 (44)	0.537
CD classification > grade III[a]	7	5	0.092
Pancreatic fistula > grade B[b]	5	5	0.719
Diarrhea	6	3	0.058
AST/ALT[c]	101/81	13/38	0.155/0.059
Intra-abdominal abscess	1	0	
Peritonitis	1	0	
MRSA pneumonia	1	0	
Pseudoaneurysm	1	0	
Relaparotomy	2	0	
30-Day mortality	1 (6)	0	0.372
Duration of hospitalization (day)	38 ± 25	56 ± 138	0.258

Numbers in parentheses indicate the percentages

[a] The Clavian–Dindo classification [28, 29]

[b] ISGPF definition [30]

[c] The serum concentration on postoperative day 1

In DP-CAR, pancreatic fistulas (ISGPF definition [30] ≥Grade B) and postoperative diarrhea were common. All patients in both groups with a pancreatic fistula eventually recovered with continuous drainage for about 3–4 weeks, and eight patients with diarrhea were regularly given loperamide hydrochloride. Only one patient who underwent DP-CAR was given a tincture of opium. The mean serum concentrations of aspartate aminotransferase (AST, normal range = 5–40 IU/l) and alanine aminotransferase (ALT, normal range = 3–35 IU/l) on postoperative day 1 in the patients who underwent DP-CAR were 101 (range = 22–476) and 81 (range = 14–389), respectively. Both returned to their normal ranges after several days, and no hepatic infarctions were clinically encountered. A relaparotomy was required in two patients. One patient suffered from bile peritonitis that developed from a stump of partial resection of the liver and open drainage was performed on the 4th postoperative day. The other patient developed a pseudoaneurysm on the stump of the CHA that was revealed by postoperative CT and angiography. The patient underwent a relaparotomy and resection of the pseudoaneurysm and ligation of the GDA on the 32nd postoperative day. Both patients recovered after surgery and were discharged in good condition. Only one patient who underwent DP-CAR died on the postoperative day 30 because of respiratory failure secondary to severe methicillin-resistant *Staphylococcus aureus* (MRSA) pneumonia. Except for this patient, there was no in-hospital mortality in both groups. The average length of postoperative hospital stay for those patients who underwent DP-CAR was a little shorter than that for DP, but there was no significant difference.

Comparison of the pathological features between DP-CAR and DP

According to histopathologic analysis, tumor size, histology, venous invasion, retropancreatic tissue invasion, portal/splenic vein invasion, celiac/SA invasion, and extrapancreatic nerve plexus invasion differed between the groups (Table 2). Regarding tumor progression (pT) for DP-CAR, eight patients had T3 tumors and eight patients had T4 tumors, and the ratio of pT3 or pT4 in this group was higher than that for DP ($P = 0.018$). Histopathologic para-aortic lymph nodes were present in two patients who underwent DP-CAR; those patients were chosen to undergo R1 resection in this study. Including these two patients, the nodal status did not reach statistical significance. R1 resection was observed in 7 of 16 patients (44%) who underwent DP-CAR. The rate was more prevalent than that for DP, although the difference was not statistically significant.

Next, we investigated the correlation between curability (R) and other clinicopathologic parameters in all 43 patients (Table 3). The number of patients with R0 resection and R1 resection was 30 (70%) and 13 (30%), respectively. The region with a positive margin presented as the pancreatic stump in five patients (38%), including two patients who underwent DP-CAR and three who underwent DP; peripancreatic margin, including retropancreatic tissue and extrapancreatic nerve system, in six patients (46%), including three who underwent DP-CAR and three who underwent DP; and two patients (15%) with microscopic metastasis of the para-aortic lymph node. As a result, R1 resection significantly correlated with PV resection, retropancreatic tissue invasion,

Table 2 Comparison of pathological features between DP-CAR and DP

	DP-CAR ($n = 16$)	DP ($n = 27$)	P
Tumor size (mm)	51 ± 16	34 ± 19	0.003
Histology (moderate/poor/mucinous)	16 (100)	20 (74)	0.035
Venous invasion (present)	13 (81)	12 (44)	0.026
Retropancreatic tissue invasion (present)	16 (100)	13 (48)	<0.001
Portal/splenic vein invasion (present)	11 (63)	9 (33)	0.032
Celiac/splenic artery invasion (present)	12 (75)	4 (15)	<0.001
Extrapancreatic nerve plexus invasion (present)	12 (75)	4 (15)	<0.001
pT			0.018
1	0	5 (19)	
2	0	3 (11)	
3	8 (50)	19 (70)	
4	8 (50)	0	
pN (present)	9 (56)	11 (44)	0.361
pM (present)	2 (12)	0	0.133
R1	7 (44)	6 (22)	0.127

Numbers in parentheses indicate the percentages

extrapancreatic nerve plexus invasion, and tumor progression (pT) ($P = 0.042$, 0.002, 0.006, and 0.040, respectively; Table 3).

Survival

Survival was significantly better in the 30 patients who had R0 resection than in the 13 patients who had R1 resection (median survival time = 28.5 vs. 9.7 months, $P = 0.046$), whereas the survival after R1 resection was significantly better than that after R2/M1 resection (Fig. 2a). In the patients who underwent DP-CAR, four patients remain alive without any evidence of cancer recurrence at 25, 9, 5, and 2 months after surgery. One patient is alive with a recurrence in the lung 24 months after surgery. The remaining ten patients died of recurrence between 4 and 39 months after surgery. The main site of the recurrence was the liver in four patients, peritoneum in four, local in one, and brain in one. The estimated overall 1- and 3-year survival rates in the patients who underwent DP-CAR were 42.6 and 25.6%, respectively, and no patients survived for more than 5 years. Their survival time was significantly worse than for those who underwent DP (median survival time = 9.7 vs. 30.9 months, $P = 0.033$, Fig. 2b). However, the patients who underwent DP-CAR had a better prognosis compared to those with R2/M1 resection ($P = 0.013$).

Discussion

Adenocarcinoma of the body and tail of the pancreas often presents at an advanced stage and is deemed unresectable

Table 3 Correlation between R1 resection and clinicopathological parameters in 43 patients

Variable	R0 resection ($n = 30$)	R1 resection ($n = 13$)	P
Age (>68 years)	15 (50)	6 (46)	0.540
Gender (male)	18 (60)	7 (54)	0.481
CEA (>2.5 ng/ml)	14 (47)	5 (38)	0.581
CA19-9 (>250 ng/ml)	16 (53)	8 (62)	0.437
Tumor location (body)	22 (73)	10 (67)	0.562
Operative procedure (DP-CAR)	9 (30)	7 (54)	0.127
Portal vein resection (present)	3 (10)	5 (38)	0.042
Tumor size (>40 mm)	11 (37)	6 (46)	0.400
Macroscopic type (nodular)	24 (80)	12 (43)	0.385
Histology (moderate/poor/mucinous)	24 (80)	7 (54)	0.731
Lymphatic invasion (present)	24 (80)	11 (85)	0.542
Venous invasion (present)	16 (53)	9 (69)	0.265
Perineural invasion (present)	23 (77)	13 (100)	0.083
Serosal invasion (present)	18 (60)	8 (62)	0.600
Retropancreatic tissue invasion (present)	16 (53)	13 (100)	0.002
Portal/splenic vein invasion (present)	15 (50)	5 (38)	0.360
Celiac/splenic artery invasion (present)	9 (30)	7 (54)	0.127
Extrapancreatic nerve plexus invasion (present)	7 (23)	9 (69)	0.006
pT (3/4)	22 (73)	13 (100)	0.040
pN (present)	12 (40)	8 (62)	0.167

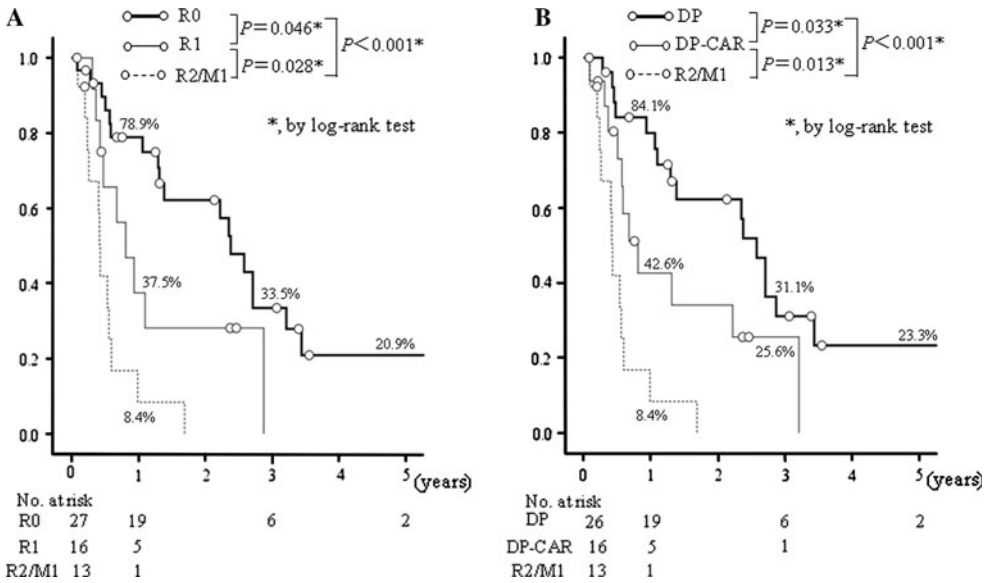

Fig. 2 **a** Survival in patients who underwent DP according to curability. **b** Survival in patients who underwent DP according to treatment modalities

in the majority of patients [5, 7]. Common reasons for the unresectability are the presence of hepatic metastases and peritoneal dissemination of the tumor. Other reasons are local invasion of the major vascular structures even in the absence of distant disease [19]. The only viable chance for a cure of this intractable cancer is surgical resection. In recent years, it has become evident that a major vascular invasion by pancreatic cancer does not always preclude a radical resection. In Japan, the resectability and 5-year survival rate of carcinoma of the body/tail of the pancreas is relatively higher than in Western countries [17, 20]. This difference may be attributed to the fact that a radical resection with an extensive clearance of the regional lymph nodes and retroperitoneal tissue is widely performed and recognized as a standard operation in Japan [6, 31, 32]. In patients in whom a pancreatic carcinoma has invaded only into the CA but not the SMA, a radical resection is possible using DP-CAR. Until now, most reports on DP-CAR or the Appleby operation have come from Japanese institutes [9, 10, 12–16, 18, 20–22], although sporadic cases have been reported from Western countries [19, 33].

The present study demonstrates that DP-CAR can be safely implemented. No differences in operative times, estimated blood loss, or length of hospital stay were detected between DP-CAR and DP, suggesting that this procedure is not unusual or difficult to manage, from our viewpoint, by adapting the extended operation routinely performed for pancreatic cancer. The current study also demonstrates a postoperative (30-day) mortality rate of 2.3% and an overall postoperative morbidity rate of 49% for all 43 patients who underwent DP, which is comparable to recent published series [7, 34–36]. The morbidity associated with DP-CAR (56%) was not increased compared to DP (44%). The frequent complications observed with DP-CAR were pancreatic fistulas and diarrhea which were not refractory to management.

During the DP-CAR operation, an important technical issue is to preserve the blood flow from the SMA via the pancreaticoduodenal arcades to the GDA and to avoid any accidental injury to the IPDA. After clamping the CA and CHA during the operation, we confirmed the blood flow to the liver and the stomach by the pulsation of the vessels and inspection of the organs' color. Doppler ultrasonography was indispensable for detecting the pulsatile arterial blood in the intrahepatic branches [22]. These methods were simple and definitive. Kondo et al. [18] reported that preoperative embolization of the CHA was successfully performed to enhance the collateral arterial flow via the IPDA. None of the 15 patients in our series, except for one who required a combined resection of the GDA, underwent a reconstruction of the hepatic artery or any attempts to enhance the arterial blood flow via the IPDA. The serum levels of ALT and AST on postoperative day 1 were elevated in five patients; however, the degree of elevation was mild and acceptable, and recovered fully within about a week. Nevertheless, to reduce the postoperative ischemic complications as much as possible, we believe that reconstruction of the hepatic artery should be done when a weak palpation of the PHA or faint intrahepatic arterial flow is observed by Doppler ultrasonography.

In the present study, the overall median survival time and 5-year survival rate for the 43 patients were 26.7 months and 16.8%, respectively. Recently, the long-term survival rate has been reported to be 10–29%, with a median survival time of 11–22 months for pancreatic body/tail cancer [1, 5, 6, 31, 37, 38]. These results show that our aggressive surgical approach to this disease is acceptable

on the whole, while the overall survival rate after DP-CAR was significantly worse than after DP. The median survival time was only 9.7 months and the overall 1- and 3-year survival rates were 42.6 and 25.6%, respectively, and in the present study, no patients survived more than 5 years. This difference was not unexpected in the current study because the disease in the patients who underwent DP-CAR was more advanced than in the patients who underwent DP (see Table 2). Hishinuma et al. [16] and Wu et al. [17] reported that patients who underwent DP-CAR were able to survive for as long as those who underwent DP without a resection of the CA, with a median survival time of 19 and 14 months, respectively. In the largest series regarding DP-CAR, which was reported by Hirano et al. [10] in 2007, the 5-year survival rate was 42% and the median survival time was 21 months. However, in their latest report in 2010 [11], the 5-year survival rate in 40 patients who underwent DP-CAR declined to 25%. In addition, Shimada et al. [6] showed that none of their 12 patients who underwent the Appleby procedure survived for more than 2 years, and their survival was significantly worse than that of patients who underwent standard DP. They proposed that the indications for this procedure for T4 carcinoma might need to be reconsidered. Yamaguchi et al. [20] also reported that three patients who underwent the Appleby operation for pancreatic body-tail carcinoma died within 2 years after the operation. The authors concluded that the indication for this operation is limited. Actually, in the English literature, there have been a few select patients who have survived for more than 5 years [10, 13, 16, 20, 23].

DP-CAR has been the only radical procedure for pancreatic body cancer with CA invasion and it has increased the resectability rate and maintained the patient's quality of life after surgery [16]. This study, however, could not suggest that there is a favorable prognosis after DP-CAR. Thinking about the causes for the lack of survival benefit after DP-CAR, the high ratio of R1 resection (44%) worried us, although it did not reach a statistical significance compared to DP. R1 resection correlated with PV resection, retropancreatic tissue invasion, extrapancreatic nerve plexus invasion, and pT. The number of patients with three of these four factors in the DP-CAR group was significantly greater than that those in the DP group (Table 3). Even when examining frozen sections, it is difficult to be certain of the precise extent of tumor invasion toward the retroperitoneal space or nerve plexus around the CA and SMA intraoperatively. Hence, preoperative imaging showing that the tumor apparently involves not only the retropancreatic fat but also the CA itself, including the circumferential nerve plexus, should be considered an indication for operation carefully in those patients, even if without SMA invasion or distant metastasis, because of poor prognosis and the possibility of R1 resection. Taking a different point of view, it may be worthwhile to adopt DP-CAR for less advanced cancer of the pancreatic body. That is to say, because this study revealed that DP-CAR was an approach without preoperative embolization of the CHA, we might attempt this operation for the tumor that extends beyond the pancreas (T3) which is attached to or is minimally invading the CHA, the origin of the SA, or the bifurcation of these arteries to secure a more surgical margin compared to DP.

In conclusion, DP-CAR is a safe and rational procedure for locally advanced pancreatic cancers. The short-term results are equivalent to those of DP. Although increasing the resectability and having the potential to achieve local control, this approach did not have a satisfactory long-term survival due to the very advanced tumors and incomplete R0 resection. DP-CAR remains an option for select patients at this time, but it has a chance of becoming a procedure for less advanced tumors of the pancreatic body. Since the number of patients who underwent DP-CAR in our study was too small, additional cases of those who can present R0 resection are needed to fully examine the long-term survival and determine any pertinent indications for this operation in patients with carcinoma of the body/tail of the pancreas.

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