


CASE REPORT

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Pancreaticoduodenectomy with reconstructing blood flow of the gastric conduit after esophagectomy with concomitant celiac axis stenosis: a case report

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Abstract

Background: Pancreaticoduodenectomy after esophageal resection is technically difficult, because blood flow of the gastric conduit should be preserved. Celiac axis stenosis (CAS) is also a problem for pancreaticoduodenectomy, because arterial blood supply for the liver comes mainly through the collateral route from the superior mesenteric artery (SMA) via the gastroduodenal artery (GDA). Herein, we report the case of a patient with pancreatic head cancer who underwent a pancreaticoduodenectomy after esophagectomy with concomitant CAS.

Case presentation: A 76-year-old man with pancreatic head cancer was referred to our department. He had a history of esophagectomy with retrosternal gastric conduit reconstruction for esophageal cancer. Computed tomography showed severe CAS and a dilated collateral route between the SMA and the splenic artery (SPA). We prepared several surgical options depending on the intraoperative findings, and performed radical pancreaticoduodenectomy with concomitant resection of the distal gastric conduit. The right gastroepiploic artery (RGEA) of the remnant gastric conduit was fed from the left middle colic artery (MCA) with microvascular anastomosis. Despite CAS, when the GDA was dissected and clamped, good blood flow was confirmed, and the proper hepatic artery did not require reconstruction. The patient was discharged on postoperative day 90.

Conclusions: We successfully performed radical pancreaticoduodenectomy after esophagectomy with concomitant CAS, having prepared multiple surgical options depending upon the intraoperative findings.

Keywords: Pancreaticoduodenectomy, Gastric conduit-preserving, Esophagectomy, Celiac artery stenosis, Microvascular reconstruction, Dorsal pancreatic artery

Background

Pancreaticoduodenectomy is a radical treatment for pancreatic head cancer. It is technically difficult to perform pancreaticoduodenectomy in patients who have undergone subtotal esophagectomy in the past, especially if

followed by reconstruction of the gastric conduit. The blood flow to the gastric conduit is usually supplied mainly by the gastroduodenal artery (GDA) via the right gastroepiploic artery (RGEA) which is divided during pancreaticoduodenectomy.

Celiac axis stenosis (CAS) is another hurdle for undergoing pancreaticoduodenectomy, and is caused by external compression or internal occlusion [1–7]. In many cases of CAS, the gastroduodenal artery (GDA) is the main collateral pathway from the superior mesenteric

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artery (SMA) to the celiac artery system through the common hepatic artery (CHA) [8, 9]. In CAS, the division of the GDA during pancreaticoduodenectomy can cause an ischemic threat, not only to the liver, stomach, and remnant pancreas, but also to the gastrojejunal, hepaticojejunal, and pancreaticojejunal anastomoses [10].

Precise preoperative diagnosis is difficult, because pancreatic cancer exhibits local invasive growth. Therefore, we are often obliged to make decisions of vascular resection and reconstruction intraoperatively. As such, based on the preoperative CT, multiple surgical choices should be prepared for different situations.

Here, we report a case of pancreaticoduodenectomy after esophagectomy with concomitant CAS.

Case presentation

A 76-year-old man had follow-up at our hospital after esophagectomy with retrosternal gastric conduit reconstruction for esophageal cancer, which had been performed 8 years earlier. Multi-detector computed tomography (MDCT) revealed a low-dense mass of 24 × 20 mm in the pancreatic head and infiltration to the anterior superior pancreaticoduodenal artery (ASPDA). The tumor also had attachment to the superior mesenteric vein (SMV) of less than 180 degrees (Fig. 1a). The gastric conduit was receiving its blood supply mainly from the RGEA, according to the arterial phase of dynamic CT. The RGEA was involved in the tumor. Furthermore, in this case, the celiac axis had severe stenosis.

There was considerable calcification around the stenosis of the celiac artery; therefore, the cause of the stenosis was suspected to be arteriosclerosis. Although the arterial pathway between the proper hepatic artery (PHA) and the SMA were developed through the GDA, we identified well-developed collateral flow from the SMA to the splenic artery (SPA) via the DPA (Fig. 1b). Tumor markers were elevated, with a CEA of 5.6 ng/ml, and CA19-9 of 706 U/ml. Endoscopic ultrasound-guided fine-needle aspiration (EUS-FNA) revealed adenocarcinoma. The patient was diagnosed with advanced pancreatic head cancer as T2, N1, M0, and Stage IIB, according to the UICC-TNM classification, 8th Edition [11]. The tumor had no contact to SMA nor celiac axis, and contact to SMV was less than 180 degrees. According to NCCN guidelines, the resectability status would be resectable. However, we judged this case as unresectable due to the infiltration of the RGEA, because only this artery supplied arterial blood flow to the gastric conduit. Therefore, the patient received chemotherapy (nab-paclitaxel plus gemcitabine for 14 cycles). In our institution, we discuss the indication of conversion surgery after chemotherapy in case-by-case situation. In this case after 11 months of chemotherapy, we planned to perform a pancreaticoduodenectomy, because there was neither progression of the tumor nor distant metastases, CEA decreased to 5.0 ng/ml and CA19-9 to 344 U/ml, and the patient strongly requested to receive the operation. For CAS, before performing a pancreaticoduodenectomy, we tried inserting an endovascular stent for the purpose of securing blood

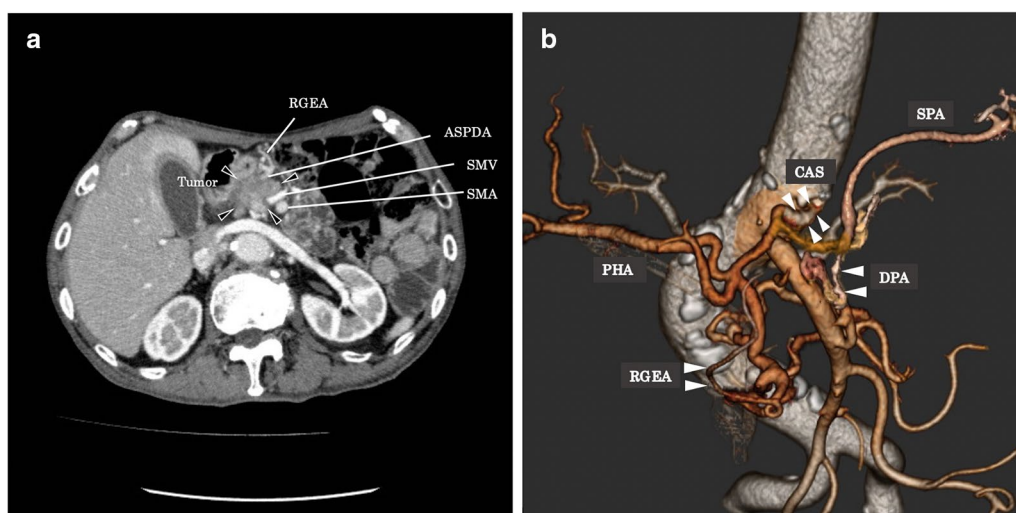


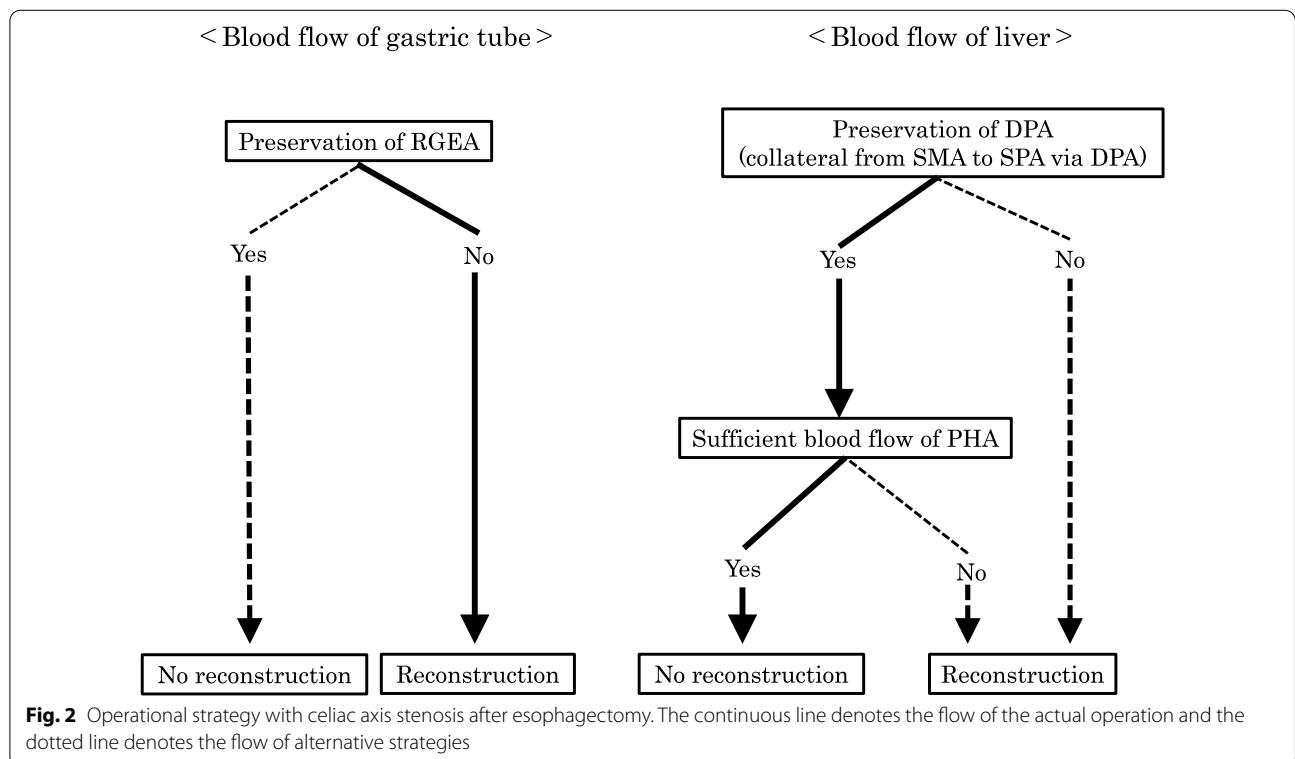
Fig. 1 Axial view and three-dimensional reconstruction using a preoperative abdominal contrast-enhanced computed tomography. **a** Iso-dense mass (arrowheads) in the pancreatic head with attachment on the anterior superior pancreaticoduodenal artery (ASPDA). **b** Celiac artery stenosis (CAS) and branch from the superior mesenteric artery (SMA) to the splenic artery (SPA) via the dorsal pancreatic artery (DPA) before pancreaticoduodenectomy

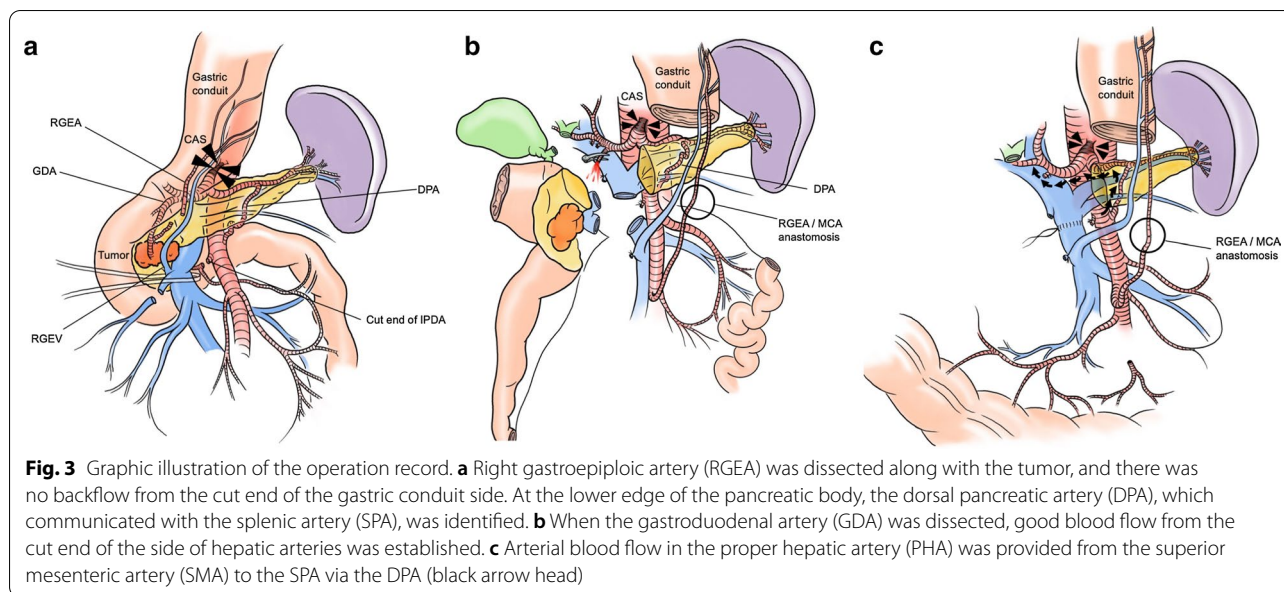
flow of the PHA when dissecting the GDA during pancreaticoduodenectomy. We failed to place the stent due to severe stenosis, but confirmed blood flow from the SMA to the SPA via the DPA, which was detected at MDCT (Fig. 1b).

Next, we planned to reconstruct the RGEA using the middle colic artery (MCA) during pancreaticoduodenectomy for preserving blood flow of the gastric conduit. We also planned to revascularize the PHA using the jejunal artery of the Roux-en-Y loop in case we could not preserve the DPA, which is the collateral pathway from the SMA to the SPA, or in case of deficient blood flow in the CHA after division of the PHA or the GDA in spite of preserving the DPA (Fig. 2). If the root of the GDA is involved in the tumor, the PHA should be cut and reconstructed. If the root of the GDA is tumor-free, the GDA is ligated and divided, and should be reconstructed in case of insufficient blood flow in the PHA after clamping of the GDA.

The root of the RGEA showed tumor involvement on the preoperative CT, and the RGEA was cut at the marginal site of the remnant gastric conduit during the operation. There was no backflow from the cut end of the gastric conduit side; therefore, it was reconstructed using MCA microscopically. The RGEV could be preserved because of its distance from the tumor. Although the right gastric artery had been preserved

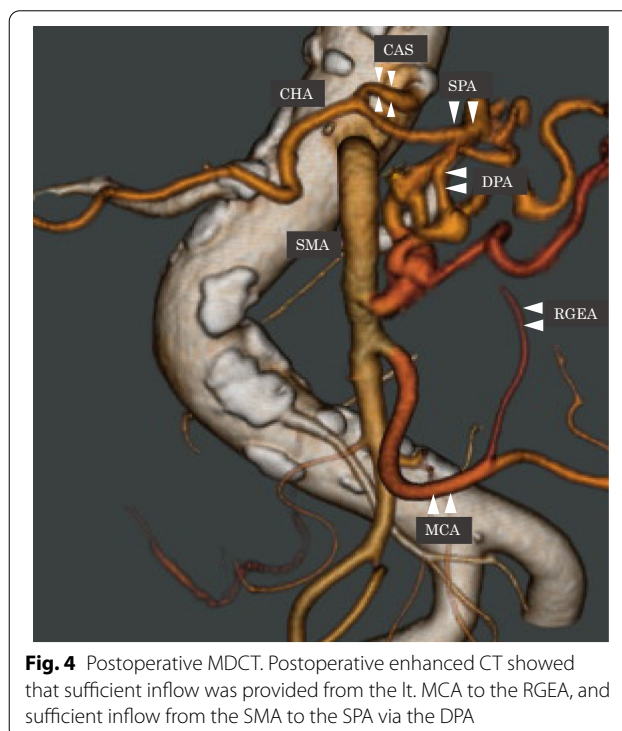
during esophagectomy in this case, this artery was not detected at MDCT before PD. Furthermore, during PD, the right gastric artery was not palpable, and we divided this artery at the root. Using a supra-colic anterior artery-first approach [12], we dissected the trunk of the inferior pancreaticoduodenal artery (IPDA) and the first jejunal artery (J1a). The second nerve plexus of the pancreatic head (PLph-II) was dissected, preserving the nerve plexus around the SMA (PL sma). At the lower edge of the pancreatic body, the DPA, which communicated with the SPA, was identified (Fig. 3a). The gastric conduit was divided on the oral side of pyloric ring. In this case, the GDA was confirmed tumor-free intraoperatively, and blood flow after clamping of the GDA was sufficient by color Doppler ultrasonography, suggesting that the collateral circulation from the SMA to the SPA via the DPA worked sufficiently. As a result, reconstructing the PHA was unnecessary (Fig. 2). When the GDA was divided (Fig. 3b), we confirmed that the tumor had also invaded the SMV; therefore, we performed a pancreatic transection, with en bloc portal vein resection (20 mm long), and end-to-end reconstruction. The left branch of the middle colic artery (lt. MCA) was used to reconstruct the RGEA. End-to-end suturing of lt. MCA and RGEA was performed with 9-0 NYLON suture (CROWNJUN Inc., Japan) under an operating microscope (Fig. 3b, c). A retrocolic pancreaticojejunostomy, a





choledochojejunostomy, and an antecolic gastrojejunostomy were performed, in this order, with a single jejunal loop. Then, a Braun anastomosis was performed between the afferent and efferent parts of the jejunal loop, which were involved in the gastrojejunostomy. Good blood flow of the remnant gastric conduit was confirmed by ICG-fluorescence imaging.

The total length of the operation was 598 min and the total blood loss was 350 ml. A blood transfusion with 280 ml was performed. We did not use antithrombotic therapy. A minor leakage of the gastrojejunostomy occurred in day 22. Endoscopy showed no ischemic change at the gastric conduit, and the case could be managed conservatively. We judged as functional recovery at day 43, and started S-1. However, the patient developed minor aspiration pneumonia after starting S-1, and needed swallowing rehabilitation for a while and discharged from hospital on postoperative day 90. Postoperative enhanced CT showed that sufficient inflow was provided from the lt. MCA to the RGEA, and sufficient inflow from the SMA to the SPA via the DPA (Fig. 4). Macroscopically, a 2.8 × 3.2 × 3.0 cm-sized, ill-circumscribed and whitish mass was seen, mainly located in the pancreatic head. Microscopically, the tumor was an invasive ductal carcinoma mainly composed of moderately differentiated tubular components. The carcinoma infiltrated the common bile duct, duodenum, peripancreatic fat tissue, and portal vein. Metastasis of the carcinoma to a lymph node (No. 13) located in the peripancreatic head was found. All surgical margins of the bile duct, duodenum, and pancreas were free from carcinoma. The chemotherapeutic effect



determined by pathological observation was Grade IIa according to the EVANS classification, and Grade 3 according to the CAP classification [13, 14]. The overall pathological stage was T3, N1, M0, and Stage IIB, according to the UICC-TNM classification (Fig. 5a–d) [11]. Fifteen months after the surgery, the patient was alive with no recurrence.

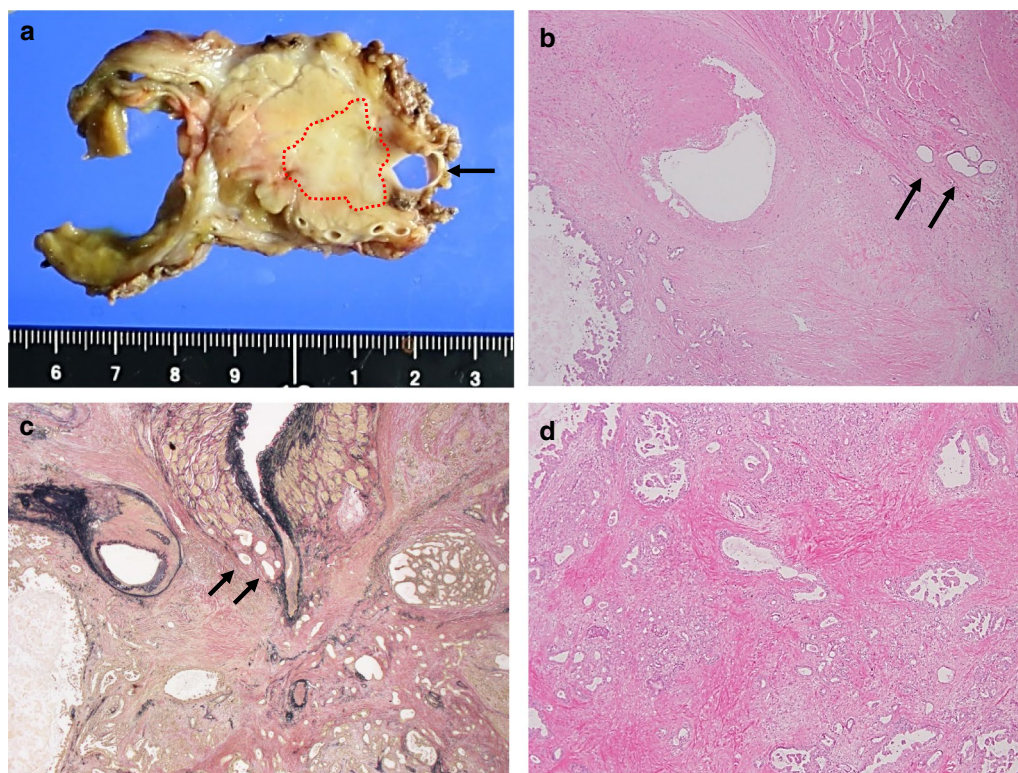


Fig. 5 Macroscopic and microscopic view of the resected specimen. **a** The cut section of the resected specimen shows an ill-circumscribed and whitish mass (red dot) in the pancreas, invading the portal vein (arrow) and peripancreatic fat. **b–d** Microscopically, tubular carcinoma was seen with sclerotic stroma, invading the portal vein (arrows in **b** and **c**). [**b** and **d**: hematoxylin and eosin stain, **c**: Elastic van Gieson stain]

Discussion

Here, we report a successful resection of a locally advanced pancreatic head cancer in a patient with a history of esophagectomy and CAS. Both esophagectomy and CAS are major problems jeopardizing pancreaticoduodenectomy from the viewpoint of preserving the blood flow of the residual organs. Modern imaging technology can offer detailed information on vessel anatomy; however, a precise diagnosis of tumor infiltration is often difficult to make. We successfully performed the resection having prepared multiple surgical options to choose from based on the intraoperative findings.

In this case, the RGEA showed tumor involvement on the preoperative MDCT; therefore, there was no choice of preserving the RGEA. There have been several reports of successful pancreaticoduodenectomy associated with esophagectomy (Table 1) [15–34]. The RGEA can be preserved in patients with non-pancreatic ductal adenocarcinoma; however, in two cases, it has been described as difficult [30, 31]. Inoue et al. reported radical pancreaticoduodenectomy with microvascular anastomosis of the cut end of the GDA and RGEA to secure the arterial blood flow of the gastric conduit [30]. We chose

MCA to reconstruct the RGEA, because we mainly use MCA to reconstruct left gastric arteries during distal pancreatectomy with celiac axis resection to preserve blood flow of the stomach, and we are experienced in the procedure [35]. Reconstruction of the RGEA using MCA has also been reported by Okochi et al. [31]. ICG-fluorescence imaging is helpful to confirm blood flow in the remnant stomach [36]. Our patient developed minor leakage at the site of the gastrojejunostomy. It was thought that the anastomotic leakage was not due to ischemia, but because the gastric conduit was drawn into the vertical space creating continuous tension in the anastomosis. The postoperative CT revealed patency of MCA-RGEA anastomosis, and upper gastroscopy revealed no ischemic change around the leaking point or specific mucosal changes associated with ischemic gastropathy [37].

CAS was another problem in our case. There are many reports of pancreaticoduodenectomy with CAS. Causes of CAS could be median arcuate ligament syndrome (MALS) or atherosclerosis, which remain controversial [3, 38]. At first, we tried to improve blood flow by placing a vascular stent as reported by Sakorafas et al. [39]. Due

Table 1 Pancreaticoduodenectomy after esophagectomy with a gastric conduit

Author	Year	Age	Sex	Diagnosis	Interval between esophagectomy and PD (month)	Operation	Preservation	Reconstruction	Operation time (min)	Blood loss (ml)	Complication	Recurrence / RFS (month)
Maeta [15]	1994	63	M	Pancreatic head carcinoma	72	PD	RGEA and V	None	-	-	None	None/12
Watanabe [16]	1995	65	M	Pancreatic metastasis of esophageal carcinoma	18	PD	RGEA and V	None	-	-	None	-
Hamaji [17]	1999	67	M	Gastric tube carcinoma	240	PD	None	None	-	-	Delayed oral intake	None/12
Kaneko [18]	2000	71	M	IPMC of the pancreatic head	108	PD	RGEA	None	-	-	Pancreatic fistula	None/11
Toyoda [19]	2001	75	F	Carcinoma of the ampulla of Vater	132	PPPD	RGEA	None	-	-	None	None/6
Kurosaki [20]	2003	58	M	Bile duct carcinoma	60	PPPD	RGEA and V	None	-	-	None	-
Uehara [21]	2004	57	M	IPMN of the pancreatic head	24	PD	RGEA and V	None	-	-	None	-
Tanaka [22]	2005	69	M	Carcinoma of the ampulla of Vater	14	PPPD	RGEA and V	None	555	425	None	None/36
Ikeda [23]	2006	63	M	Pancreatic head carcinoma	120	PD	RGEA and V	None	600	1080	None	None/12
Tobita [24]	2009	81	M	IPMN of the pancreatic head	72	DPPHR	RGEA and V	None	-	-	None	None/48
Hatori [25]	2009	70	M	Pancreatic head carcinoma	96	PD	RGEA and V	None	-	-	None	Yes/10
Yada [26]	2010	77	M	Duodenal carcinoma	204	PD	RGEA and V	None	-	-	None	None/18
Ando [27]	2010	67	M	Carcinoma of the ampulla of Vater	60	PPPD	RGEA and V	None	277	445	None	None/36
Addeo [28]	2011	73	M	Pancreatic metastasis of renal cell carcinoma	72	PPPD	RGEA and V	None	300	300	Pancreatic fistula	-
Fragulidis [29]	2011	50	M	Pancreatic head carcinoma	156	PPPD	RGEA	None	420	800	None	None/6

Table 1 (continued)

Author	Year	Age	Sex	Diagnosis	Interval between esophagectomy and PD (month)	Operation	Preservation	Reconstruction	Operation time (min)	Blood loss (ml)	Complication	Recurrence / RFS (month)
Inoue [30]	2014	72	M	Pancreatic head carcinoma	120	PD	Reconstruction	GDA and RGEA / RGEV and LRV	863	3000	None	None/6
Okochi [31]	2015	70	M	Pancreatic head carcinoma	60	PD	Reconstruction	MCA and RGEA	-	-	-	None/8
Orii [32]	2019	79	M	Pancreatic head carcinoma	60	PPPD	RGEA and V	None	-	-	None	None/63
Izumi [33]	2019	78	M	Pancreatic head carcinoma	84	PD	RGEA and V	None	492	652	None	None/5
Honig [34]	2020	72	M	Pancreatic head carcinoma	132	PPPD	RGEA and V	None	-	-	Duodenojejunostomy leak	-
Ours	2020	76	M	Pancreatic head carcinoma	96	PD	RGEV Reconstruction	MCA and RGEA	598	350	Gastrojejunostomy leak	None/15

DPPHR duodenum-preserving pancreatic head resection, *GDA* gastroduodenal artery, *IPMC* intraduct papillary mucinous carcinoma, *IPMN* intraduct papillary mucinous neoplasm, *LRV* left renal vein, *MCA* middle colic, *PD* pancreaticoduodenectomy, *PPPD* pylorus-preserving pancreaticoduodenectomy, *RFS* recurrence-free survival, *RGEA* right gastroepiploic artery, *V* right gastroepiploic vein

to the severe stenosis, it failed to function. CAS results in the development of major collateral pathways (GDA or DPA) that arise from the SMA, resulting in the feeding of the CHA branches through retrograde flow via the GDA or the arc of Buhler [8, 9, 39, 40]. However, in patients with CAS who have developed a collateral pathway through the GDA that is sacrificed during pancreaticoduodenectomy, we must consider how to preserve the arterial flow of the liver. To prevent ischemia after pancreaticoduodenectomy, interventional radiology, arterial reconstruction, and median arcuate ligament division surgery have been considered [3, 10, 39, 41–45]. In contrast, Oikawa et al. reported a procedure similar to the present case which identified well-developed collateral circulation between the SMA and the SPA through the DPA and dissected GDA with any preoperative intervention or reconstruction in patients with CAS [46]. In our case, we identified well-developed blood flow from the SMA to the SPA via the DPA and successfully preserved blood flow without reconstructing the PHA. Some investigators have argued that the division of GDA during pancreaticoduodenectomy in patients with CAS does not always result in ischemic complications of the upper abdominal organs, reporting that only 13–17% of patients with CAS required arterial reconstruction during pancreaticoduodenectomy, because abundant collateral circulation beyond the pancreatic head arcade might develop between the CA tributaries and SMA tributaries [1–3]. We had planned to revascularize the PHA using the jejunal artery of the Roux-en-Y loop in the case of deficient blood flow in the PHA after dissecting the GDA (Fig. 2). Fortunately, based on the intraoperative findings, we were able to preserve blood flow in the hepatic artery without reconstruction due to the sufficient collateral blood flow from the SMA to the PHA via the DPA.

Conclusion

In conclusion, we report a successful pancreaticoduodenectomy for pancreatic head cancer in a patient with a history of esophageal resection and CAS. Both history of esophageal resection and CAS are major problem in pancreaticoduodenectomy; therefore, careful planning based on the MDCT helps ensure a successful surgery.

Abbreviations

ASPSA: Anterior superior pancreaticoduodenal artery; CAS: Celiac axis stenosis; CHA: Common hepatic artery; DPA: Dorsal pancreatic artery; EUS-FNA: Endoscopic ultrasound-guided fine-needle aspiration; GDA: Gastrooduodenal artery; IPDA: Inferior pancreaticoduodenal artery; JA1: First jejunal artery; MALS: Median arcuate ligament syndrome; MCA: Middle colic artery; MDCT: Multi-detector computed tomography; PHA: Proper hepatic artery; pPh-II: Second nerve plexus of the pancreas head; pl-SMA: Nerve plexus around the SMA; RGEA: Right gastroepiploic artery; RGEV: Right gastroepiploic vein; SMA: Superior mesenteric artery; SMV: Superior mesenteric vein; SPA: Splenic pancreatic artery.

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Authors' contributions

MM and IH drafted the manuscript and were responsible for the case report. MM, IH, YR, GY, IH, MY, YH, and SA performed the surgery and were responsible for the perioperative management of the patient. FY helped draft the pathological part of the manuscript. KK assisted in drawing the anatomical figure. KY advised on the details of esophagectomy. SA is the corresponding author and revised the manuscript. All authors equally took part in the conception of the case study, treating the patient and revising the manuscript. All authors read and approved the final manuscript.

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Availability of data and materials

Not applicable.

Ethics approval and consent to participate

This study was approved by the Juntendo University ethics committee (JHS 19–018 Juntendo University Hospital Independent Ethics Committee).

Consent for publication

Written informed consent was obtained from the patient for publication of this case report.

Competing interests

The authors declare that they have no competing interests.

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References

1. Trede M. The surgical treatment of pancreatic carcinoma. *Surgery*. 1985;97:28–35.
2. Pfeiffenberger J, Adam U, Drognitz O, Kröger JC, Makowiec F, Schareck W, et al. Celiac axis stenosis in pancreatic head resection for chronic pancreatitis. *Langenbecks Arch Surg*. 2002;387:210–5.
3. Berney T, Pretre R, Chassot G, Morel P. The role of revascularization in celiac occlusion and pancreatoduodenectomy. *Am J Surg*. 1998;176:352–6.
4. Portolani N, Tiberio GA, Coniglio A, Baiocchi G, Vettoretto N, Giulini SM. Emergency celiac revascularization for supramesocolic ischemia during pancreaticoduodenectomy: report of a case. *Surg Today*. 2004;34:616–8.
5. Farma JM, Hoffman JP. Nonneoplastic celiac axis occlusion in patients undergoing pancreaticoduodenectomy. *Am J Surg*. 2007;193:341–4 (discussion 4).
6. Gaujoux S, Sauvanet A, Vullierme MP, Cortes A, Dokmak S, Sibert A, et al. Ischemic complications after pancreaticoduodenectomy: incidence, prevention, and management. *Ann Surg*. 2009;249:111–7.
7. Yamamoto M, Itamoto T, Oshita A, Matsugu Y. Celiac axis stenosis due to median arcuate ligament compression in a patient who underwent

- pancreatoduodenectomy; intraoperative assessment of hepatic arterial flow using Doppler ultrasonography: a case report. *J Med Case Rep.* 2018;12:92.
8. Song SY, Chung JW, Kwon JW, Joh JH, Shin SJ, Kim HB, et al. Collateral pathways in patients with celiac axis stenosis: angiographic-spiral CT correlation. *Radiographics.* 2002;22:881–93.
 9. Heo S, Kim HJ, Kim B, Lee JH, Kim J, Kim JK. Clinical impact of collateral circulation in patients with median arcuate ligament syndrome. *Diagn Interv Radiol.* 2018;24:181–6.
 10. Thompson NW, Eckhauser FE, Talpos G, Cho KJ. Pancreatoduodenectomy and celiac occlusive disease. *Ann Surg.* 1981;193:399–406.
 11. Brierley JD, Gospodarowicz MK, Wittekind C, eds. *UICC: TNM classification of malignant tumors.* 8th ed. Wiley Blackwell; 2017
 12. Inoue Y, Saiura A, Yoshioka R, Ono Y, Takahashi M, Arita J, et al. Pancreatoduodenectomy With systematic mesopancreas dissection using a supracolic anterior artery-first approach. *Ann Surg.* 2015;262:1092–101.
 13. Evans DB, Rich TA, Byrd DR, Cleary KR, Connelly JH, Levin B, et al. Preoperative chemoradiation and pancreatoduodenectomy for adenocarcinoma of the pancreas. *Arch Surg.* 1992;127:1335–9.
 14. Shi C, Adsay V, Bergsland E, Berlin J, Branton P, Fitzgibbons P, et al. College of American pathologist, protocol for the examination of specimens from patients with carcinoma of the pancreas. 2017 Version: PancreasExocrine 4.0.0.1.
 15. Maeta M, Mizusawa K, Yamashiro H, Oka A, Kondo R, Kaibara N. Gastric tube-preserving pancreatoduodenectomy for metachronous pancreatic cancer after thoracic esophagectomy (in Japanese). *Shujutsu (Operation).* 1994;48(2):189–93.
 16. Watanabe O, Tsuchiya Y, Tsutsui M, Nashimoto A, Sasaki J. A case of metastatic pancreas tumor resected by gastric tube pre- serving pancreatoduodenectomy in a patient who underwent esophagectomy (in Japanese). *Rinshogeka (J Clin Surg).* 1995;50(3):355–9.
 17. Hamaji M, Kuhara A, Miyazaki K, Nishida Y, Sakaguchi H, Ishida M, et al. Pancreatoduodenectomy for gastric tube carcinoma 20 years after esophagectomy: a case report (in Japanese). *Shujutsu (Operation).* 1999;53(2):243–5.
 18. Kaneko T, Sugihara S, Kobayashi H, Harada H, Ikuta Y, Egami T, et al. An operative case of a mucin producing pancreatic tumor 9 years after the first operation of esophageal and pulmonary cancers (in Japanese with English abstract). *Nihon Syokakigeka Gakkaizasshi (Jpn J Gastroenterol Surg).* 2000;33(6):735–9.
 19. Toyoda S, Chijiwa K, Nakano K, Yamaguchi K, Tanaka M. Pancreatoduodenectomy with preservation of the pylorus and gastroduodenal artery for carcinoma of ampulla of Vater after esophageal resection (in Japanese). *Shujutsu (Operation).* 2001;55(1):155–8.
 20. Kurosaki I, Hatakeyama K. Gastric tube preserving pancreato- duodenectomy for metachronous esophageal cancer and bile duct cancer (in Japanese). *Shujutsu (Operation).* 2003;57(9):973–6.
 21. Uehara H, Kondo S, Hirano S, Ambo Y, Tanaka E, Katoh H. Gastric tube-preserving pancreatoduodenectomy after esophagectomy and reconstruction using the gastric tube: report of a case. *Surg Today.* 2004;34:623–5.
 22. Tanaka K, Anbo Y, Hirano S, Tanaka E, Morikawa T, Kondo S. Pylorus-preserving pancreatoduodenectomy for the ampulla of Vater carcinoma after esophagectomy with reconstruction of gastric tube: a case report (in Japanese with English abstract). *Tando (J Jpn Biliary Assoc).* 2005;19(1):98–101.
 23. Ikeda M, Hasegawa K, Akamatsu N, Minagawa M, Imamura H, Sugawara Y, et al. Pancreatoduodenectomy after esophageal and gastric surgery preserving right gastroepiploic vessels. *Arch Surg.* 2006;141:205–8.
 24. Tobita K, Imaizumi T, Ishii M, Fujihira T, Izumi H, Furukawa D, et al. Duodenum preserving pancreas head resection (DPPHR) after esophageal and gastric surgery preserving right gastroepiploic Vessels (in Japanese). *Tan to Sui (Bile Pancreas).* 2009;30(1):47–52.
 25. Hatori T, Fujita I, Yagawa Y, Izumi T, Takazaki K, Yamamoto M. Pancreatoduodenectomy after esophagectomy with reconstruction of gastric tube (in Japanese). *Tan to Sui (Bile Pancreas).* 2009;30(1):33–8.
 26. Yada K, Matsumoto T, Kusano T, Masuda T, Takeuchi H, Hayashi H, et al. A case of duodenal cancer treated successfully by gastric tube-preserving pancreatoduodenectomy after esophagectomy (in Japanese with English abstract). *Nihon Syokakigeka Gakkaizasshi (Jpn J Gastroenterol Surg).* 2010;43(4):385–90.
 27. Ando M, Shimizu Y, Yasui K, Sano T, Senda Y, Yamao K, et al. A case report of pylorus preserving pancreatoduodenectomy with gastric-tube preservation for carcinoma of papilla of Vater after esophagectomy (in Japanese with English abstract). *Tando (J Jpn Biliary Assoc).* 2010;24(1):119–26.
 28. Addeo P, Marzano E, Rosso E, Bachellier P, Jaeck D, Pessaux P. Gastroduodenal artery-preserving pancreaticoduodenectomy after subtotal esophagectomy and gastric pull-up. *Langenbecks Arch Surg.* 2011;396:693–7.
 29. Fragulidis GP, Athanasopoulos PG, Melemini A, Chondrogiannis KD, Nastos K, Koutoulidis V, et al. Pylorus-preserving pancreaticoduodenectomy after transhiatal esophagectomy sparing the right gastroepiploic vessels and gastric tube. *J Gastrointest Surg.* 2011;15:367–70.
 30. Inoue A, Akita H, Eguchi H, Hama N, Wada H, Kawamoto K, et al. Gastric conduit-preserving, radical pancreaticoduodenectomy with microvascular reconstruction for pancreatic head cancer after esophagectomy: report of a case. *Surg Today.* 2014;44:786–91.
 31. Okochi M, Ueda K, Sakaba T, Kenjo A, Gotoh M. Right gastro-omental artery reconstruction after pancreaticoduodenectomy for subtotal esophagectomy and gastric pull-up. *Int J Surg Case Rep.* 2015;15:42–5.
 32. Orii T, Yoshimura M, Kitahara H, Karasawa Y. Pylorus-preserving pancreatoduodenectomy for pancreatic head cancer after surgery for esophageal cancer with gastric tube reconstruction in a long-term survivor: a case report. *Int J Surg Case Rep.* 2019;55:92–8.
 33. Izumi H, Yoshii H, Abe R, Yamamoto S, Mukai M, Nomura E, et al. Pancreatoduodenectomy following surgery for esophageal cancer with gastric tube reconstruction: a case report and literature review. *Surg Case Rep.* 2019;5:191.
 34. Honig SE, Lundgren MP, Kowalski TE, Lavu H, Yeo CJ. Advanced endoscopic rescue of a complication (duodenojejunosotomy leak) after a pylorus-preserving pancreaticoduodenectomy in a post-esophagectomy patient with pancreatic adenocarcinoma: a case report and review of the literature. *J Pancreat Cancer.* 2020;6:5–11.
 35. Sato T, Inoue Y, Takahashi Y, Mise Y, Ishizawa T, Tanakura K, et al. Distal pancreatectomy with celiac axis resection combined with reconstruction of the left gastric artery. *J Gastrointest Surg.* 2017;21:910–7.
 36. Oba A, Inoue Y, Sato T, Ono Y, Mise Y, Ito H, et al. Impact of indocyanine green-fluorescence imaging on distal pancreatectomy with celiac axis resection combined with reconstruction of the left gastric artery. *HPB (Oxford).* 2019;21:619–25.
 37. Okada KI, Kawai M, Hirono S, Miyazawa M, Kitahata Y, Ueno M, et al. Ischemic gastropathy after distal pancreatectomy with en bloc celiac axis resection for pancreatic body cancer. *Langenbecks Arch Surg.* 2018;403:561–71.
 38. Park CM, Chung JW, Kim HB, Shin SJ, Park JH. Celiac axis stenosis: incidence and etiologies in asymptomatic individuals. *Korean J Radiol.* 2001;2:8–13.
 39. Sakorafas GH, Sarr MG, Peros G. Celiac artery stenosis: an underappreciated and unpleasant surprise in patients undergoing pancreaticoduodenectomy. *J Am Coll Surg.* 2008;206:349–56.
 40. van Petersen AS, Kolkman JJ, Gerrits DG, van der Palen J, Zeebregts CJ, Geelkerken RH. Clinical significance of mesenteric arterial collateral circulation in patients with celiac artery compression syndrome. *J Vasc Surg.* 2017;65:1366–74.
 41. Hasegawa K, Imamura H, Akahane M, Miura Y, Takayama T, Ohtomo K, et al. Endovascular stenting for celiac axis stenosis before pancreaticoduodenectomy. *Surgery.* 2003;133:440–2.
 42. Okamoto H, Suminaga Y, Toyama N, Konishi F, Kawahito H. Autogenous vein graft from iliac artery to splenic artery for celiac occlusion in pancreaticoduodenectomy. *J Hepatobiliary Pancreat Surg.* 2003;10:109–12.
 43. Manabe T, Baba N, Setoyama H, Ohshio G, Tobe T. Venous bypass grafting for celiac occlusion in radical pancreaticoduodenectomy. *Pancreas.* 1991;6:368–71.
 44. Machado MC, Penteado S, Montagnini AL, Machado MA. An alternative technique in the treatment of celiac axis stenosis diagnosed during pancreaticoduodenectomy. *HPB Surg.* 1998;10:371–3.
 45. Takach TJ, Livesay JJ, Reul GJ Jr, Cooley DA. Celiac compression syndrome: tailored therapy based on intraoperative findings. *J Am Coll Surg.* 1996;183:606–10.
 46. Oikawa R, Ito K, Takemura N, Mihara F, Kokudo N. Arterial communication around the pancreatic tail enabled division of the gastroduodenal artery during pancreaticoduodenectomy in patient with complete celiac artery occlusion: a case report. *Surg Case Rep.* 2020;6:29.

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