

# The prevalence of circumportal pancreas as shown by multidetector-row computed tomography

Kousei Ishigami · Tsuyoshi Tajima · Akihiro Nishie · Yoshiki Asayama ·  
Daisuke Kakihara · Tomohiro Nakayama · Ken Shirabe · Akinobu Taketomi ·  
Masafumi Nakamura · Shunichi Takahata · Tetsuhide Ito · Hiroshi Honda

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## Abstract

**Objective** To evaluate the prevalence of circumportal pancreas (CP) and any coexisting anomaly. In addition, three cases of surgically confirmed CP are presented.

**Methods** The study group consisted of 317 consecutive potential liver transplant donor candidates who had undergone thin-section MDCT studies for the evaluation of vascular anatomy. MDCT images were retrospectively reviewed to assess the presence or absence of CP. If CP was present, the transverse diameter of the aberrant pancreatic tissue was measured on axial images, and the

course of the main pancreatic duct (MPD) was classified into ante-portal (normal) or retro-portal. In addition, the prevalence of variant hepatic arterial anatomy was compared between cases with and without CP.

**Results** Eight of 317 liver transplant donor candidates (2.5%) were found to have CP at CT. The transverse diameter of the aberrant pancreatic tissue ranged from 5 to 18 mm (mean±SD: 10±4 mm). One of eight (12.5%) showed the MPD to be retro-portal. A variant hepatic artery was noted in two of the eight (25%) patients, which was similar to the finding for those without CP [72 out of 309 (23%)].

**Conclusion** The prevalence of circumportal pancreas was 2.5%.

K. Ishigami (✉) · T. Tajima · A. Nishie · Y. Asayama ·  
T. Nakayama · H. Honda  
Department of Clinical Radiology,  
Graduate School of Medical Sciences, Kyushu University,  
3-1-1 Maidashi, Higashi-ku,  
Fukuoka 812-8582, Japan  
e-mail: Ishigamikousei@aol.com

K. Shirabe · A. Taketomi  
Department of Surgery and Science,  
Graduate School of Medical Sciences, Kyushu University,  
Fukuoka, Japan

M. Nakamura · S. Takahata  
Department of Surgery and Oncology,  
Graduate School of Medical Sciences, Kyushu University,  
Fukuoka, Japan

T. Ito  
Department of Medicine and Bioregulatory Science,  
Graduate School of Medical Sciences, Kyushu University,  
Fukuoka, Japan

D. Kakihara  
Department of Molecular Imaging and Diagnosis,  
Graduate School of Medical Sciences, Kyushu University,  
Fukuoka, Japan

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## Introduction

Circumportal pancreas is a pancreatic anomaly, showing complete pancreatic encasement of the portal vein above the spleno-portal junction [1]. If circumportal pancreas is present, additional resection of the aberrant pancreatic tissue (i.e. anomalous connection between the dorsal and ventral pancreas at the left side of the main portal vein) is necessary for pancreatic head resection [2]. In addition, it has been reported that circumportal pancreas may cause a pancreatic fistula to emerge from the stump of aberrant pancreatic tissue [2, 3]. It is therefore important to note the presence of circumportal pancreas in patients for whom pancreatic head resection is planned.

There have been only five previous literature reports including eight cases of circumportal pancreas [1–5], and this anomaly has been believed to be extremely rare.

However, the prevalence of circumportal pancreas and any coexisting anomaly is uncertain.

The purpose of this study was to evaluate the prevalence of circumportal pancreas using thin-section multi-detector-row computed tomography (MDCT) studies.

## Materials and methods

The study group consisted of 317 consecutive liver transplant donor candidates who had undergone contrast-enhanced multi-detector row CT (MDCT) for the evaluation of vascular anatomy between April 2006 and March 2010. There were 180 male and 137 female patients. Ages ranged from 19 to 64 years [mean±standard deviation (SD): 37±12 years old].

Contrast-enhanced MDCT studies were performed on a 64-detector-row MDCT (Aquilion; Toshiba Medical Systems, Tokyo, Japan) with a gantry rotation time of 0.5 s. Each patient received intravenous (IV) non-ionic contrast material. The dose of IV contrast material (maximum dose of 150 ml) was determined based on the body weight: 1.71 ml/kg for 350 mg I/ml iohexol (Omnipaque 350; Daiichi-Sankyo, Tokyo, Japan) and 1.62 ml/kg for 370 mg I/ml iopamidol (Iopamiron 370; Bayer-Schering, Osaka, Japan). IV contrast material was injected by means of an automated power injector with an injection duration of 20 s (maximum injection rate of 5 ml/s), and 20 ml of saline was subsequently injected at the same injection rate. The patient body weight, the dose of IV contrast and the injection rate ranged from 37 to 90 kg (mean±SD: 59.8±10.3 kg), 62 to 146 ml (mean±SD: 97.7±15.9 ml) and 3.1 to 5.0 ml/s (mean±SD: 4.6±0.5 ml/s), respectively. The CT parameters were as follows: section collimation, 0.5 mm; helical pitch 53; 125 mAs; and 120 kVp. The arterial phase was determined by the bolus tracking method. The region of interest was established on the abdominal aorta at the level of the celiac axis. The portal venous phase was obtained 70 s after the initiation of intravenous injection of contrast agent. The section thicknesses of the arterial and portal venous phases were 1 mm and 2 mm, respectively.

Two experienced radiologists reviewed 317 MDCT studies to evaluate the presence or absence of circumportal pancreas in a consensus fashion. Multiplanar reformatted (MPR) images were obtained from the portal venous phase by a three-dimensional (3D) computer workstation (AquariusNET; TeraRecon Inc., San Mateo, CA). Circumportal pancreas was regarded as present when the main portal vein above the level of the spleno-portal junction was completely encircled by the pancreatic parenchyma on axial images, and when aberrant pancreatic tissue extending behind the main portal vein and fusing with the pancreatic body was confirmed by MPR images created by the 3D workstation. If circumportal pancreas was present, the reviewers measured the transverse diameter of the aberrant pancreatic tissue in the axial plane. The measurements were performed twice, and the average data were recorded. Additionally, the course of the main pancreatic duct (MPD) was classified into two types: ante-portal (normal) and retro-portal. Furthermore, if a variant hepatic arterial anatomy was present, it was recorded.

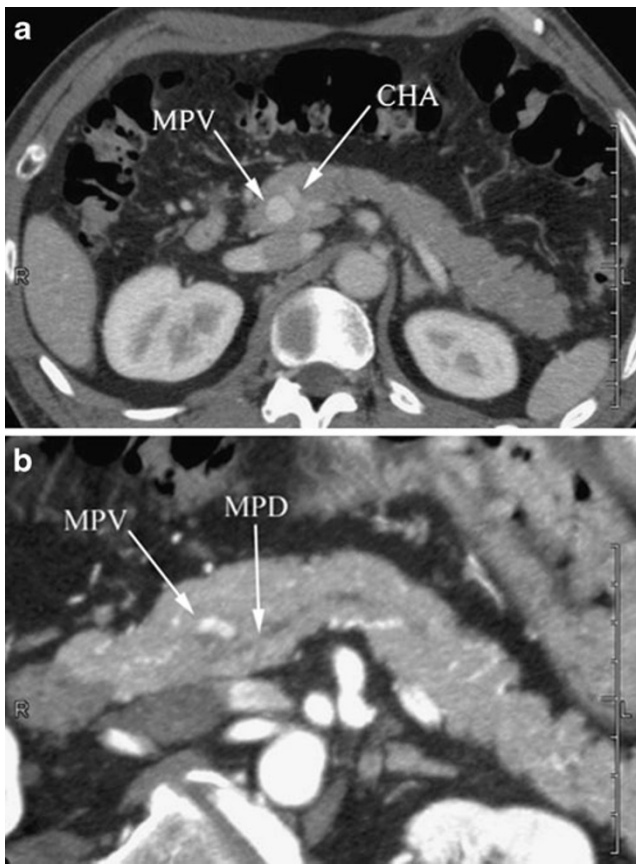
## Results

Circumportal pancreas was noted in 8 of the 317 liver transplant donor candidates (2.5%). In one case, one of the reviewers mistakenly characterized circumportal pancreas as the inferior edge of the caudate lobe of the liver. The interobserver agreement was achieved in the remaining seven cases. The transverse diameter of the aberrant pancreatic tissue ranged from 5 mm to 18 mm [mean±standard deviation (SD): 10±4 mm]. The transverse diameter of the main portal vein (MPV) at the same level ranged from 12 mm to 18 mm (mean±SD: 15±3 mm). Narrowing of the MPV was not seen. These results are summarized in Table 1. One of the eight (12.5%) showed that the main pancreatic duct (MPD) ran behind the portal vein (retroportal MPD; Fig. 1a). Other pancreatic ductal anomalies such as pancreatic divisum were not observed in any of these eight cases.

**Table 1** Eight cases of circumportal pancreas in 317 liver transplant donor candidates

Age	Sex	Size (mm) <sup>a</sup>	Hepatic arterial anatomy	Course of the MPD
31	M	5 mm	Standard	Ante-portal
27	M	13 mm	Replaced LHA	Ante-portal
31	M	12 mm	Standard	Ante-portal
26	M	8 mm	Replaced RHA	Ante-portal
31	F	10 mm	Standard	Ante-portal
52	F	11 mm	Standard	Ante-portal
54 <sup>b</sup>	M	18 mm	Standard Encasement of CHA	Retro-portal
58	F	5 mm	Standard	Ante-portal

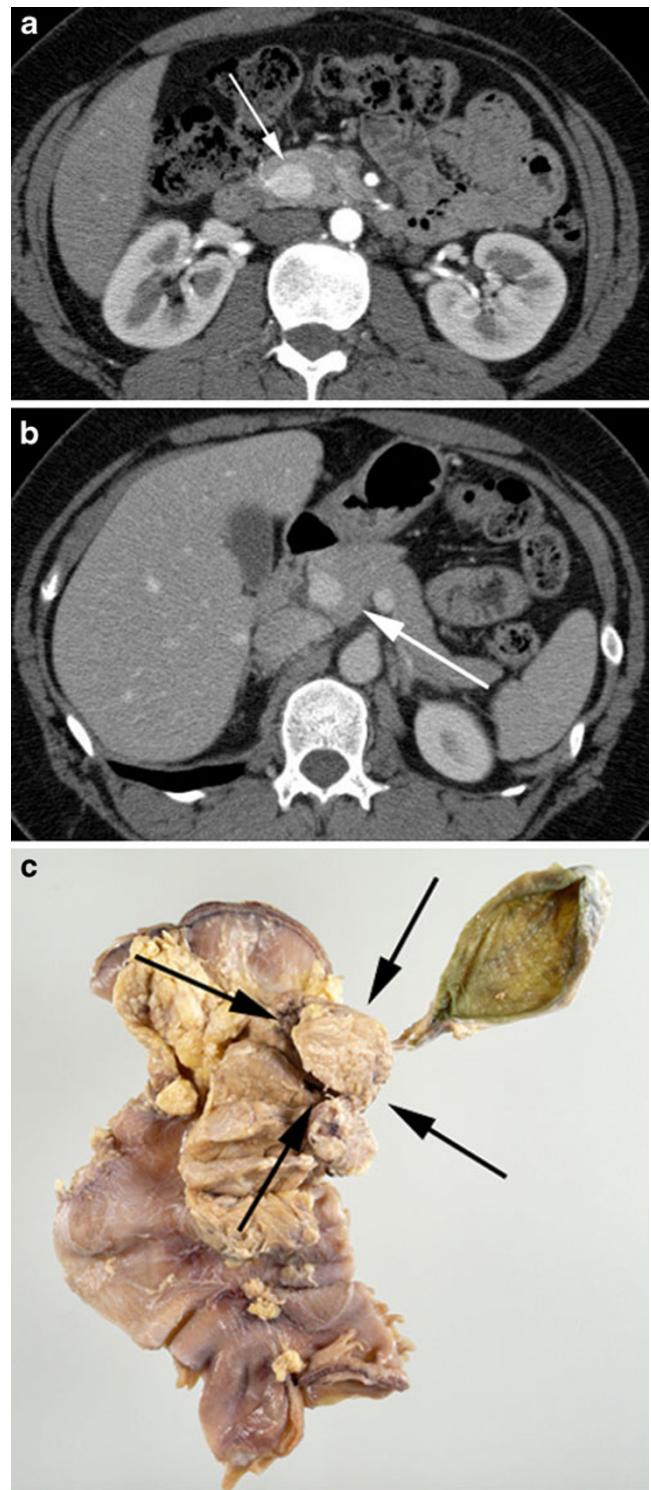
<sup>a</sup> Size indicates the transverse diameter of aberrant pancreatic tissue. <sup>b</sup> This case is presented as case 1. MPD=main pancreatic duct. LHA=left hepatic artery. RHA=right hepatic artery. CHA=common hepatic artery



**Fig. 1** A 54-year-old male liver transplant donor candidate with circumportal pancreas, retroportal main pancreatic duct and encasement of the common hepatic artery. **a** Oblique axial multiplanar reformatted (MPR) image obtained from the portal venous phase shows encasement of the main portal vein (MPV) and the common hepatic artery (CHA) by pancreatic parenchyma. **b** Oblique axial MPR image obtained from the arterial phase demonstrates that the main pancreatic duct (MPD) runs behind the MPV (retroportal MPD)

Two of the eight (25%) circumportal pancreas cases had variant hepatic arterial anatomy: a replaced right hepatic artery (RHA) from the superior mesenteric artery (SMA) (n=1) and a replaced left hepatic artery (LHA) from the left gastric artery (LGA) (n=1), respectively. Additionally, in one case the common hepatic artery (CHA) ran through the pancreatic parenchyma, and encasement of the CHA was also noted.

In liver transplant donor candidates without circumportal pancreas, 72 out of 309 (23.3%) cases had variant hepatic arterial anatomy, including the replaced/accessory RHA (n=23), the accessory/replaced LHA (n=18), both the replaced and accessory RHA, and the accessory and replaced LHA (n=15), the hepatomesenteric trunk or replaced proper hepatic artery (n=12), both the replaced RHA and the replaced CHA (n=3), and the celiomesenteric trunk (n=1). Therefore, the prevalence of variant hepatic arteries was fairly similar to the prevalence of circumportal pancreas.



**Fig. 2** A 45-year-old female patient with insulinoma of the pancreatic head and circumportal pancreas. **a** The arterial phase of MDCT shows a hypervascular pancreatic head tumor, consistent with insulinoma (arrow). **b** The portal venous phase of axial MDCT demonstrates aberrant pancreatic tissue (arrow) encircling the MPV. **c** Photograph of the resected specimen from behind. Arrows indicate aberrant pancreatic tissue

## Case presentation

### Case 1

A 54-year-old man who was a liver transplant donor candidate underwent MDCT for the evaluation of vascular anatomy. MDCT showed circumportal pancreas with a coexisting anomaly including a retroportal main pancreatic duct and encasement of the common hepatic artery (Fig. 1).

### Case 2

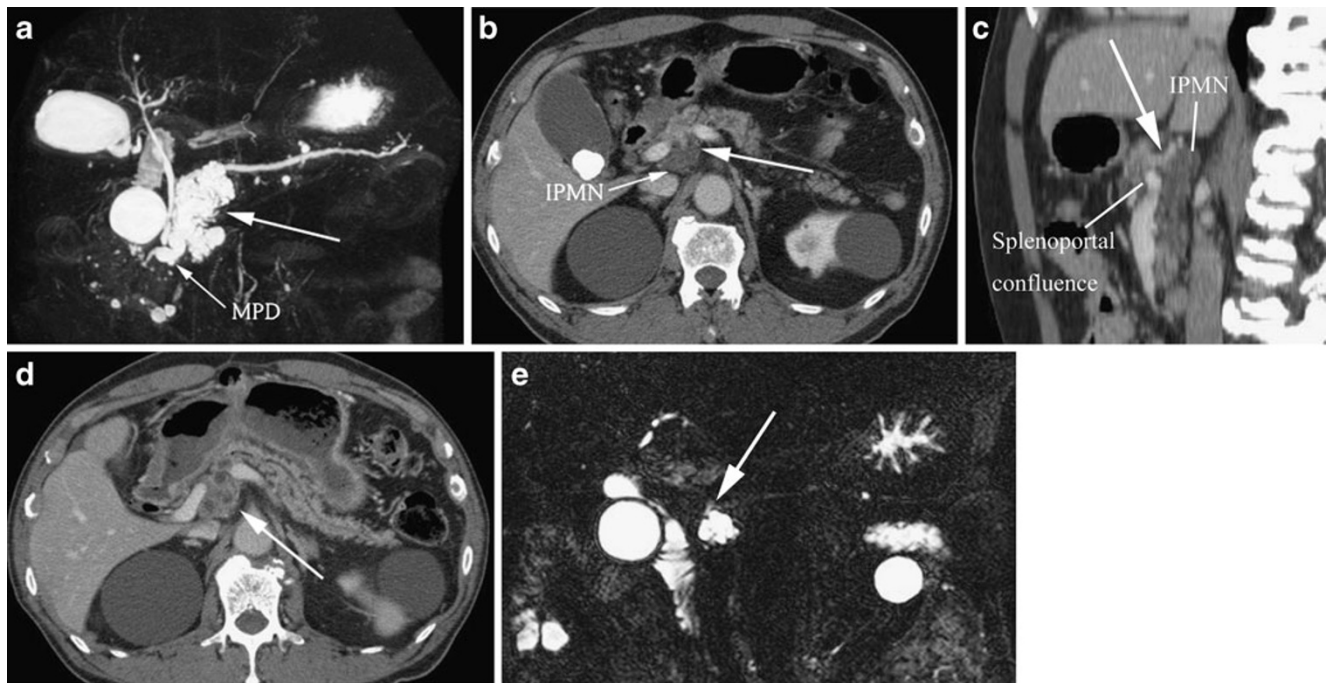
A 45-year-old woman presented with loss of consciousness due to hypoglycemia. Her serum blood sugar was 30 mg/dl [normal range (NR): 69–109 mg/dl], and her immunoreactive insulin (IRI) was 172.8  $\mu$ U/ml (NR: 1.0–18.0  $\mu$ U/ml). Contrast-enhanced dynamic MDCT showed a 2-cm hypervascular pancreatic head tumor, consistent with pancreatic insulinoma (Fig. 2a). In retrospect, MDCT demonstrated circumportal pancreas (Fig. 2b). Circumportal pancreas was noticed during pancreatoduodenectomy. Additional resection of the aberrant pancreatic tissue was performed (Fig. 2c). The postoperative course was uneventful.

### Case 3

An 80-year-old patient underwent MDCT for postoperative follow-up study. He had had a history of pancreatic head resection with segmental duodenectomy for intraductal papillary mucinous neoplasm (IPMN) 6 months previously (Fig. 3). Follow-up MDCT demonstrated a 2-cm multilocular cystic mass at the posterior aspect of the portal vein (Fig. 3d). Magnetic resonance cholangiopancreatography (MRCP) showed the communication between the main pancreatic duct and the cystic lesion (Fig. 3e). In retrospect, preoperative MDCT showed circumportal pancreas (Fig. 3b, c). We suspected that the cystic lesion represented regrowth of residual IPMN. Surgical resection of the cystic lesion was performed, and intraoperative findings showed the cystic lesion to be connected to an aberrant pancreatic tissue. The cystic lesion turned out to be a retention cyst with granulation tissues. There was no residual IPMN component.

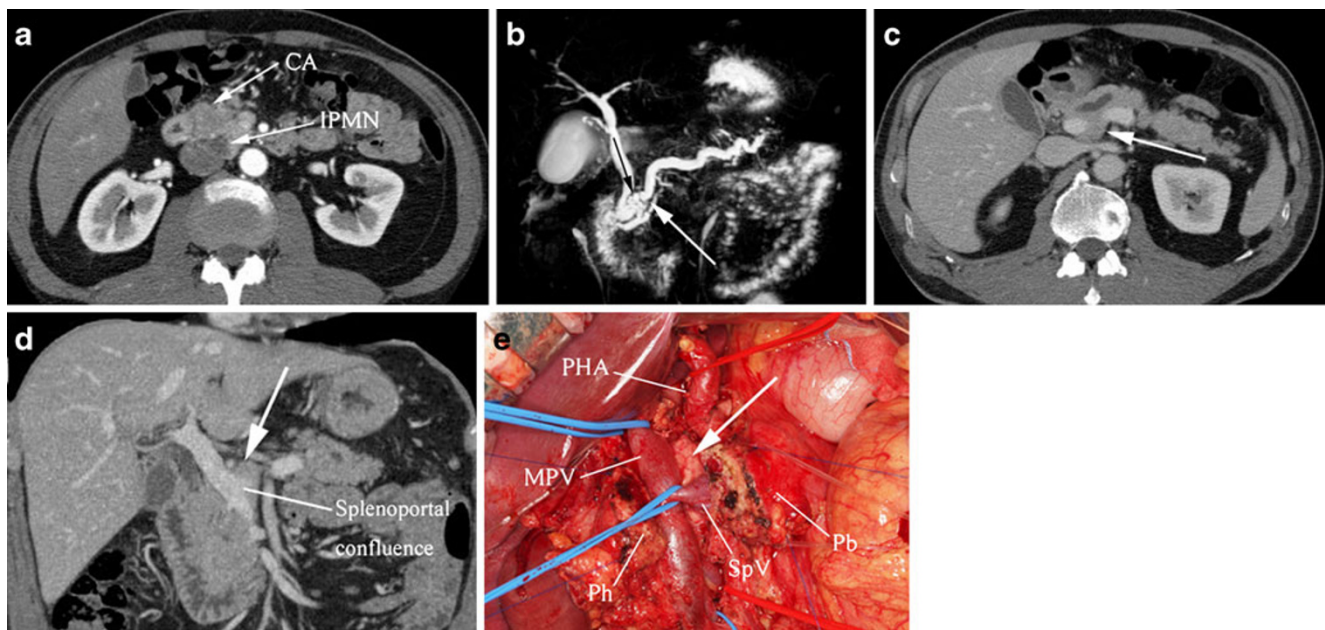
### Case 4

A 65-year-old asymptomatic male patient was discovered to have elevated serum amylase levels and a pancreatic head



**Fig. 3** An 80-year-old male patient with intraductal papillary mucinous neoplasm (IPMN) of the pancreatic head and circumportal pancreas. **a** Preoperative magnetic resonance cholangiopancreatography (MRCP) shows multilocular cystic mass with dilatation of the downstream main pancreatic duct (MPD) in the pancreatic head, consistent with IPMN (large arrow). **b** The portal venous phase of preoperative MDCT shows circumportal pancreas. IPMN component extends to an aberrant pancreatic tissue (large arrow). **c** Sagittal

reformatted image obtained from the portal venous phase shows an aberrant pancreatic tissue (arrow) above the splenoportal confluence as well as IPMN. **d** Follow-up MDCT 6 months after the segmental duodenectomy for IPMN demonstrates a 2-cm multilocular cystic mass at the dorsal aspect of the portal vein (arrow). **e** Source image of coronal MRCP shows the communication between the main pancreatic duct and the cystic lesion (arrow). The cystic lesion turned out to be a retention cyst with granulation tissues



**Fig. 4** A 45-year-old male patient with pancreatic head cancer, IPMN and circumportal pancreas. **a** The arterial phase of MDCT shows a hypoattenuating mass in the anterior portion of the pancreatic head, consistent with pancreatic cancer (CA). A cystic mass is seen in the posterior portion of the pancreatic head, representing pancreatic IPMN (IPMN). **b** MRCP shows a multilocular cystic mass, consistent with IPMN (black arrow). Obstruction of the main pancreatic duct by pancreatic head cancer is demonstrated (white arrow). **c** The portal venous phase of MDCT above the level of the spleno-portal junction

shows encasement of the main portal vein, representing circumportal pancreas. Arrow indicates an aberrant pancreatic tissue. Dilatation of the main pancreatic duct is seen. **d** Coronal reformatted image obtained from the portal venous phase shows an aberrant pancreatic tissue above the splenoportal confluence (arrow). **e** Intraoperative finding. An aberrant pancreatic tissue is noted behind the main portal vein (arrow). Ph=pancreatic head. Pb=pancreatic body. MPV=main portal vein. SpV=splenic vein. PHA=proper hepatic artery

mass at an outside hospital. Serum amylase was 418 U/l (NR: 42–132 U/l). Carcinoembryonic antigen (CEA) was 1.4 ng/ml (NR:  $\leq 3.2$  ng/ml), and carbohydrate antigen 19–9 (CA 19–9) was 84.7 U/ml (NR:  $\leq 37.0$  U/mL). MDCT revealed a 3-cm solid mass in the anterior portion of the pancreatic head (Fig. 4a, b). There was a 2-cm multilocular cystic mass in the posterior portion of the pancreatic head (Fig. 4a, b). In addition, circumportal pancreas was noted (Fig. 4c, d).

With the diagnosis of pancreatic head cancer and branch duct-type IPMN, pylorus-preserving pancreatoduodenectomy and additional resection of an aberrant pancreatic tissue were performed. Circumportal pancreas was confirmed surgically (Fig. 4e). The postoperative course was uneventful. The pathological diagnosis was pancreatic head adenocarcinoma and benign intraductal papillary mucinous adenoma.

## Discussion

Our study showed that 2.5% of liver transplant donor candidates (8 out of 317) had circumportal pancreas. This result suggests that the prevalence of circumportal pancreas is

not extremely low. This anomaly has not received adequate attention in preoperative imaging studies. If an aberrant pancreatic tissue is small, it may be difficult to spot during the surgical procedure. In addition, the degree of pancreatic fistula from a small aberrant pancreatic tissue may be subclinical if drainage tubes are placed appropriately.

The embryogenesis of the pancreas is complex. The ventral pancreatic primordium rotates and fuses with the dorsal pancreatic primordium. Circumportal pancreas may result from the higher fusion of both primordia above the level of the spleno-portal junction. Interestingly, in one case, the common hepatic artery ran through the pancreatic head. It may also result from higher fusion of the ventral and dorsal pancreatic primordia.

In one of the eight circumportal pancreas cases (12.5%), the main pancreatic duct (MPD) was seen behind the main portal vein (retroportal MPD). Retroportal MPD was reported in three of the eight previously reported circumportal pancreas cases (37.5%) [3, 4]. Awareness of this coexisting anomaly is important for pancreatic resection because of the substantial risk of pancreatic fistula [3]. Although the mechanism of the development of retroportal MPD is unclear, it may be related to the large size of aberrant pancreatic tissue (i.e.

the large size of the ventral pancreas behind the main portal vein may increase the chance of a retroportal course of the Wirsung's duct).

In our series, two of the eight donor candidates with circumportal pancreas (25%) had variant hepatic arteries, and the prevalence of variant hepatic arteries was similar to that without circumportal pancreas (23.4%). This result suggests that there is no association between circumportal pancreas and variant hepatic arteries.

The differential diagnoses of circumportal pancreas may include peripancreatic lymphadenopathy and the inferior edge of the caudate lobe of the liver. Although we did not have surgical confirmation from liver transplant donor candidates, we believe that multiplanar reformatted (MPR) images obtained from the thin-section MDCT were sufficient to prove the presence or absence of circumportal pancreas.

In conclusion, circumportal pancreas is not extremely rare. Care should be taken regarding the presence or

absence of circumportal pancreas in patients for whom pancreatic head resection is planned.

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