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Disposal of Replaced Common Hepatic Artery Coursing Within the Pancreas During Pancreatoduodenectomy: Report of a Case

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Abstract
A replaced common hepatic artery (RCHA) originating from the superior mesenteric artery (SMA) is a rare anomaly. We herein report such a case in a 62-year-old man who was scheduled to undergo a pancreatoduodenectomy for lower bile duct cancer. Computed tomography (CT) showed the RCHA to run along the ventral side of the pancreas. Abdominal angiography showed an RCHA originating from the SMA, which communicated with an aberrant left hepatic artery from the left gastric artery. No gastroduodenal artery was observed, but instead a direct ramification of a right gastroepiploic artery was seen. Similar cases from the English literature were reviewed. The RCHA was confirmed to course first along the ventral side of, and then within, the pancreas. Clamping of the RCHA did not influence the arterial flow in the liver, and the RCHA was subsequently divided without reconstruction. In three of the five reviewed cases in which the RCHA coursed either within or along the ventral side of the pancreas, no gastroduodenal artery was found, but instead a direct ramification of a right gastroepiploic artery was observed. A combination of CT and angiographic findings can help in both the diagnosis of an anomalous RCHA coursing either within or along the ventral side of the pancreas as well as in selecting optimal operative procedures. Pancreatoduodenectomy was performed with a curative resection according to our usual practice except for the fact that we preserved the aberrant left hepatic artery.

Key words Replaced common hepatic artery · Aberrant left hepatic artery · Pancreatoduodenectomy · Bile duct cancer

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Introduction

It is unclear as to whether abdominal angiography is a necessary preoperative examination for patients who are scheduled to undergo a pancreatoduodenectomy (PD).[1,2] It is well known that the hepatic artery has numerous variations, and Suzuki and Nakayasu[2] classified these variations into three patterns: Group 1 has a single hepatic artery that originates from either the celiac artery (CA) (55%) or the superior mesenteric artery (SMA) (3.5%); Group 2 has double hepatic arteries that originate from the CA (28%), SMA (1.0%), or both (4.0%); and Group 3 has multiple hepatic arteries that originate from the CA (0.5%) or both the CA and the SMA (4.0%). The normal pattern of the hepatic artery, as usually represented in textbooks, is observed in 53.5%–75.5% of cases.[2–4] Recently, we encountered a patient with a replaced common hepatic artery (RCHA) originating from the SMA, who had undergone a PD with a division of the RCHA. In this report, we describe this case while focusing particularly on the surgical techniques and hepatic arterial development.

Case Report

A 62-year-old man was referred to our department after experiencing jaundice of 1 week's duration. Abdominal ultrasound and computed tomography (CT) demonstrated intrahepatic bile duct dilatation. The patient underwent percutaneous transhepatic bile duct drainage to reduce the jaundice. Cholangiography suggested the presence of lower bile duct cancer. Computed tomography showed the RCHA to run along the ventral side of the head of the pancreas and along the right side of the portal vein (Fig. 1). To obtain more information on the anatomical variations, abdominal angiography was performed. The examination showed a RCHA originating from the SMA (Fig. 2). The left hepatic

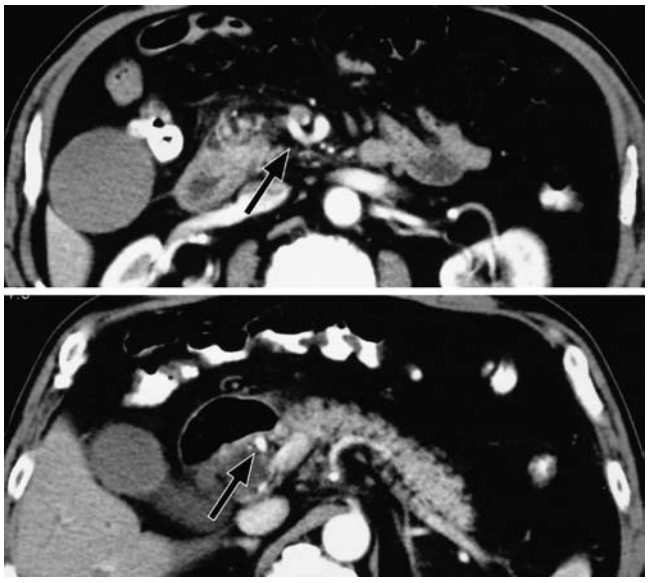

Fig. 1. Computed tomography of the 65-year-old male subject described in this case report. The *arrow* shows the replaced common hepatic artery originating from the superior mesenteric artery coursing along the ventral side of the head of the pancreas and along the right side of the portal vein

Fig. 2. Angiography showing the replaced common hepatic artery (RCHA) originating from the superior mesenteric artery. The *black arrow* shows the left hepatic artery, while the *white arrow* shows the communicating artery between the left hepatic artery and the RCHA

artery also received a blood flow from the left gastric artery (Fig. 3). The RCHA did not branch off into a gastroduodenal artery, and the right gastroepiploic artery was directly formed from the RCHA. After a diagnosis of bile duct cancer was made, the patient was scheduled to undergo a PD with a curative resection according to our usual practice except for the fact that we preserved the aberrant left hepatic artery. The RCHA was then dissected from the hepatic hilum

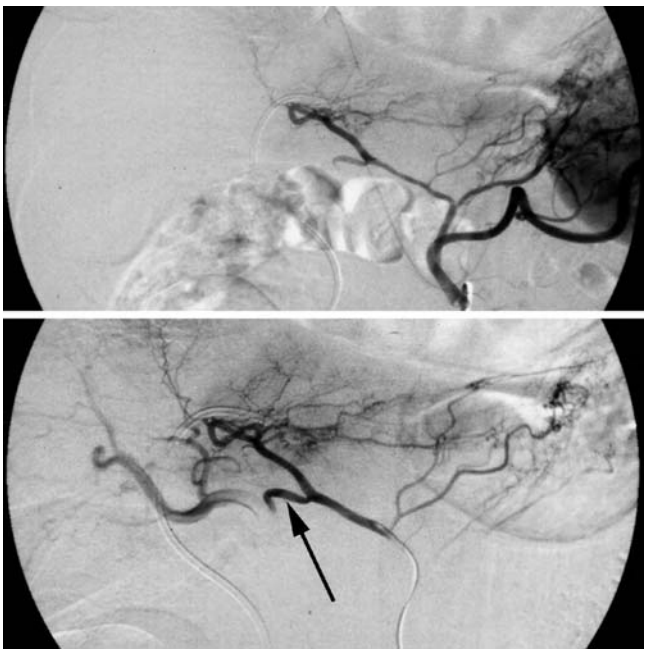

Fig. 3. Angiography showing the left hepatic artery originating from the left gastric artery. The *lower photo* shows the left hepatic artery communicating with the aberrant left hepatic artery from the left gastric artery (*arrow*)

toward the pancreas. No gastroduodenal artery was present, but small arterial branches were observed to enter into the pancreas, and the RCHA was confirmed to enter the pancreas. The connection between the RCHA and the left gastric artery was not exposed by a standard dissection of the lymph nodes. After clamping the RCHA, an adequate arterial blood flow in the right and left hepatic lobes was confirmed by intraoperative color Doppler ultrasonography. We decided to divide the artery at the same level in order to divide the common hepatic duct. The RCHA was also divided at its root from the SMA. Subsequently, PD was accomplished without any negative effect on curability. Macroscopically, the RCHA was found to course first along the ventral side of the pancreas and thereafter within the pancreatic parenchyma (Fig. 4). The bile duct cancer was assessed to be stage III (T2, N1a, M0) according to the TNM classification. Postoperatively, the patient had no liver dysfunction, bile leakage, or any other major complications. The patient is presently doing well without any signs of recurrence at 31 months after surgery.

Discussion

When planning a PD, knowledge of the hepatic arterial blood supply is essential for avoiding unnecessary com-

plications, which can be obtained by CT, magnetic resonance imaging, or angiography. In particular, when the liver receives a blood supply from the SMA, the branches can course behind, within, or along the ventral side of the pancreas. The incidence of RCHA originating from the SMA has been reported to be 1.5%–4.0%.[1,3,4] In 200 liver dissections, Michels[3] found that half of the RCHAs actually coursed through the pancreatic parenchyma, while the other half passed posterior to the pancreas. Higashi and Hirai[5] classified the hepatic arterial variations arising from the SMA into four types with some subgroups (Fig. 5), and according to their classifications, in types III-A (the artery coursing in front of the superior mesenteric vein) and IV-A (the artery coursing behind the superior mesenteric vein), the RCHAs ascended along the ventral side of the pancreas. These authors reported one case of each type. Type III-A was first reported by Ohtsuka et al. in 1984.[6] Woods and Traverso[7] also reported one case of a RCHA coursing along the ventral surface of the pancreas, in which the patient successfully underwent a PD with a preservation of the artery. Our patient, in whom the RCHA coursed behind the superior mesenteric vein and then along the ventral side of the pancreas, was considered to belong to type IV-A. However, the cranial part of the artery coursed along the ventral side of the pancreas and then was buried within the pancreatic parenchyma; therefore the division of the RCHA was required to complete the PD. In three of the five reviewed cases, including the present one, in which the RCHA coursed either within or along the ventral side of the pancreas and detailed ramifications of the artery were demonstrated,[5,7,9] there was no gastroduodenal artery, with a direct ramification of the right gastroepiploic artery from the RCHA. In the remaining two cases, however, a gastroduodenal artery originated from the RCHA. When the former findings are observed on angiography, the CT findings should be

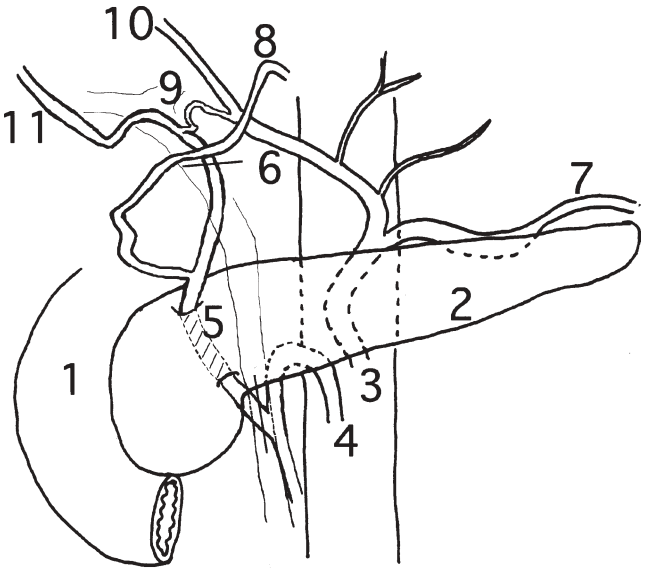

Fig. 4. Schematic rendition of the replaced common hepatic artery coursing first on the ventral side of the pancreas and then within the pancreatic parenchyma. The part represented by the *oblique line* was buried within the pancreas. The *lines* indicate the proximal and distal division lines of the replaced right hepatic artery, respectively. *1*, duodenum; *2*, pancreas; *3*, celiac trunk; *4*, superior mesenteric artery; *5*, replaced common hepatic artery (RCHA); *6*, left gastric artery; *7*, splenic artery; *8*, right gastroepiploic artery; *9*, the connection between the RCHA and the left gastric artery; *10*, left hepatic artery; *11*, right hepatic artery

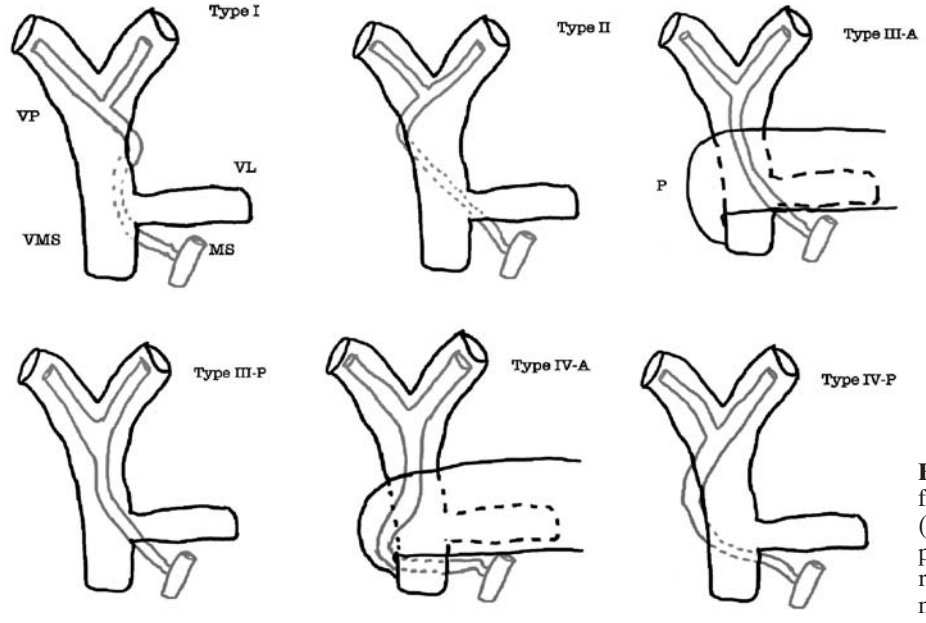

Fig. 5. Types of hepatic arteries arising from the superior mesenteric artery (from [5], with permission). *VP*, vena portae; *VMS*, vena mesenterica superior; *VL*, vena lienalis; *MS*, arteria mesenterica superior; *P*, pancreas

carefully re-evaluated to determine whether or not the RCHA courses along the ventral side of the pancreas. In our patient, the CT findings suggested that the artery coursed along the ventral side of the pancreas and, subsequently, angiography was performed. The combination of the CT and angiographic findings can assist with the diagnosis of the anomalous arterial development and for selecting the appropriate operative procedures.

The common variations of CAs and SMAs can be explained by the persistence of either some or all of the primitive ventral anastomoses of the vitelline arteries and associated variations in the preservation of the 10 and 13 vitelline roots.[8] The RCHA that courses behind the pancreas and then enters the gastroduodenal artery can be explained by this theory. However, the RCHA that courses along the ventral side of the pancreas and then enters directly into the right gastroepiploic artery and without the presence of the gastroduodenal artery, cannot be explained by this theory alone. In addition to this theory, the abnormal development of the anterior pancreatoduodenal artery, gastroduodenal artery, and proper hepatic artery may also contribute to this rare anomalous coursing of the RCHA along the ventral side of the pancreas.[5]

The importance of sparing this artery during PD lies not so much in preventing hepatic ischemia but in preventing a breakdown of biliary-enteric anastomosis, because the blood supply to the cranial part of the bile duct is entirely dependent on the right hepatic artery after a PD.[7] When a PD is scheduled for patients with the RCHA coursing in, or along, the ventral side of the pancreas, five methods can be employed for preserving the hepatic arterial blood flow. First, the artery in the pancreas can be preserved by dividing the pancreatic parenchyma. Furukawa and Shimada[9] described a patient with a RCHA which ran into the pancreas and was preserved by dividing the pancreas. There is a risk with this technique of possibly spreading cancer cells, because the division line of the pancreas is likely to deviate toward the right side from the line of the standard PD. Second, when the RCHA courses along the ventral side of the pancreas, following a dissection of the artery from the pancreatic parenchyma, PD can be performed in the usual manner.[7] Third, when the RCHA is connected to either the left gastric artery or an accessory artery, the artery can be divided without reconstruction. In our patient, after the artery had been clamped, an adequate arterial blood flow in the liver was confirmed by intraoperative color Doppler ultrasonography, and postoperatively no liver dysfunction, bile leakage, or other major complications were observed. Fourth, the artery can be divided and reconstructed. This technique may increase the risk of potentially fatal postoperative bleeding if a pancreatic fistula occurs. Finally, in theory it is possible to preserve the right gastric artery by performing a pylorus-preserving PD and the RCHA can be divided without reconstruction. This procedure may be applicable when a cancer is not very advanced, but there have so far been no reports of using this modality under such circumstances.

In summary, we herein reported a rare case of RCHA that coursed along the ventral side of, and thereafter within, the pancreas. When PD is being planned, it is important to consider this rare anatomical variant while carefully analyzing the characteristic findings of CT and abdominal angiography.

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