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Case report

Imaging diagnosis of aberrant proper hepatic and gastroduodenal arteries prior to pancreaticoduodenectomy: A case report☆,☆☆

Yosuke Namba, MD[a], Koichi Oishi, MD, PhD[a,], Sho Okimoto, MD, PhD[a], Toshiyuki Moriuchi, MD[a], Tomoaki Bekki, MD[a], Shoichiro Mukai, MD, PhD[a], Yasufumi Saito, MD, PhD[a], Seiji Fujisaki, MD, PhD[a], Mamoru Takahashi, MD[a], Toshikatsu Fukuda, MD, PhD[a], Hideki Ohdan, MD, PhD[b]*

[a] *Department of Surgery, Chugoku Rosai Hospital, Hiroshima, Japan*
[b] *Department of Gastroenterological and Transplant Surgery Applied Life Sciences, Institute of Biomedical and Health Sciences, Hiroshima University, Hiroshima, Japan*

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ABSTRACT

In hepatobiliary and pancreatic surgery, an understanding of hepatic artery anomalies is of great importance to surgeons. Cases of the proper hepatic artery originating from the superior mesenteric artery and the gastroduodenal artery originating from the celiac trunk are extremely rare. To our knowledge, there are no reports of these arterial variants being diagnosed before hepatobiliary and pancreatic surgery. A 73-year-old woman underwent subtotal stomach-preserving pancreaticoduodenectomy and lymphadenectomy for duodenal carcinoma. Preoperative vascular construction with 3-dimensional computed tomography showed variants of the proper hepatic artery and gastroduodenal artery. The proper hepatic artery originated from the superior mesenteric artery, and the gastroduodenal artery originated from the celiac trunk. Intraoperative findings and preoperative vascular construction from 3-dimensional computed tomography were found to be matched exactly; both the proper hepatic artery and gastroduodenal artery were preserved. By diagnosing a rare arterial variant preoperatively, we were able to perform the surgery safely. In hepatobiliary and pancreatic surgery, understanding any potential variation of the hepatic artery before surgery is crucial to ensure the best patient outcomes.

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* Corresponding author.
E-mail address: silentman1087@yahoo.co.jp (K. Oishi).

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Introduction

Understanding the anatomy, including abnormal development of the hepatic artery (HA), is of paramount importance while performing surgeries requiring manipulation of major vessels in the hepatobiliary and pancreatic areas [1]. The celiac trunk (CeT) is the first major branch of the abdominal aorta and divides into 3 branches: the left gastric artery (LGA), splenic artery (SA), and common hepatic artery (CHA) [2]. The CHA divides into the gastroduodenal artery (GDA) and proper hepatic artery (PHA), which are the main sources of blood supply to the liver and gallbladder [3]. There are some reports on variations in the anatomy of the HA in the anatomic, radiographic, and surgical literature [4–6].

Cases with the PHA originating from the superior mesenteric artery (SMA) and GDA originating from the CeT are extremely rare. To our knowledge, these arterial variations have only been observed in 2 cases, both of which were discovered during cadaveric dissection [7,8].

In this paper, we report a rare case in which the origin of the PHA from SMA and the origin of the GDA from CeT were identified by preoperative diagnostic imaging, and pancreaticoduodenectomy (PD) was then successfully performed for papillary carcinoma.

Case report

A 73-year-old woman presented with jaundice and general malaise. Laboratory data showed an increase in hepatobiliary enzymes, and she was referred to our hospital for further examination. Her medical history included surgery for cholecystitis, and she was not on any medication. Enhanced computed tomography (CT) showed stenosis of the common bile duct in the duodenal papilla and dilation of the common bile duct (Fig. 1). An endoscopic nasobiliary drainage tube was placed for biliary decompression. A biopsy of the papilla showed adenocarcinoma, and we performed subtotal-stomach preserving PD and lymphadenectomy.

Preoperative vascular construction using 3-dimensional CT (3D-CT) is shown in Fig. 2. The CHA was absent and as for its branching pattern, the PHA and GDA originated from the SMA and CeT, respectively. The GDA branched into the right gastroepiploic artery (RGEA) and superior pancreaticoduodenal artery (SPDA), and a thin communicating branch was found between the PHA and GDA. The CeT gave off the LGA and SA in addition to the GDA (Fig. 2A). The PHA ascended between the common bile duct and portal vein, and branched into the right and left hepatic arteries (Fig. 2B). To preserve the hepatic arterial blood supply, we planned to maintain the communicating branch and resect the RGEA and SPDA. Intraoperative findings and preoperative vascular construction from 3D-CT were found to be exactly matched. The GDA branched into the RGEA and SPDA, and a thin communicating branch was discovered between the PHA and GDA (Fig. 3A). Both the PHA and GDA were preserved, and the RGEA and SPDA were resected individually. After resection, it was confirmed that the PHA originated from the SMA (Fig. 3B). The regional lymph nodes of the papillary carcinoma were dissected. The operative time was 544 minutes, and the blood loss was 410 g. Fig. 4 illustrates the arterial variations in this case. The patient's postoperative course was uneventful. Histopathological examination revealed a moderately differentiated ductal adenocarcinoma of the duodenum that invaded the papilla of the Vater, pancreas, and bile duct, and confirmed an R0 type of resection. The tumor was classified as fT4N2M0 fStage IIIB (TNM Classification of Malignant Tumors, Eighth Edition) [9].

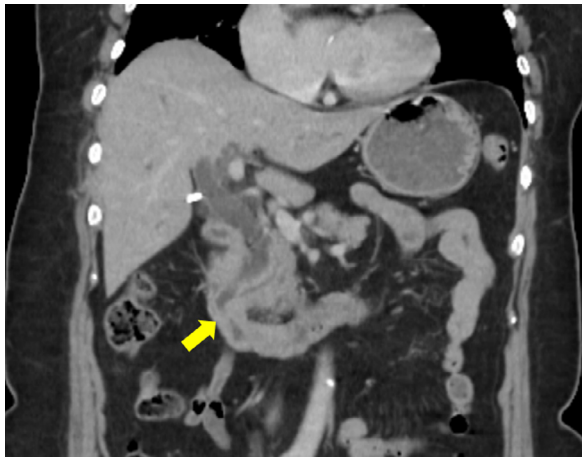

Fig. 1 – Enhanced computed tomography (CT). Enhanced CT imaging showing stenosis of the common bile duct in the duodenal papilla (yellow arrow) and dilation of the common bile duct (Color version of the figure is available online.)

Discussion

The presence of HA variations was first reported by Haller in 1756 [10], and several classifications for HA variations have been proposed since [4–6]. The embryologic context of HA is important for understanding how these variants occur. Four ventral vessels (left gastric artery, SA, CHA, and SMA) stem from the abdominal aorta. These splanchnic arteries are paired vessels that are interconnected by longitudinal anastomoses. During development, the longitudinal anastomosis between the SA and SMA roots is interrupted, leading to anatomic separation of the CeT from the SMA. These changes in the vascular development process lead to the emergence of several variations in the CeT and SMA [11]. In this case, the CHA was completely regressed, and the PHA appeared from the SMA, which then bifurcated into the left hepatic artery (LHA) and right hepatic artery (RHA). The GDA originated from the CeT.

Few reports have found PHA to be the first branch of the SMA, and GDA to be a branch of the CeT, as was seen in this case. Huang et al. suggested 6 types of variations in the absence of the CHA; however, the type in which the PHA originates from the SMA, as seen in this case, remains unclassi-

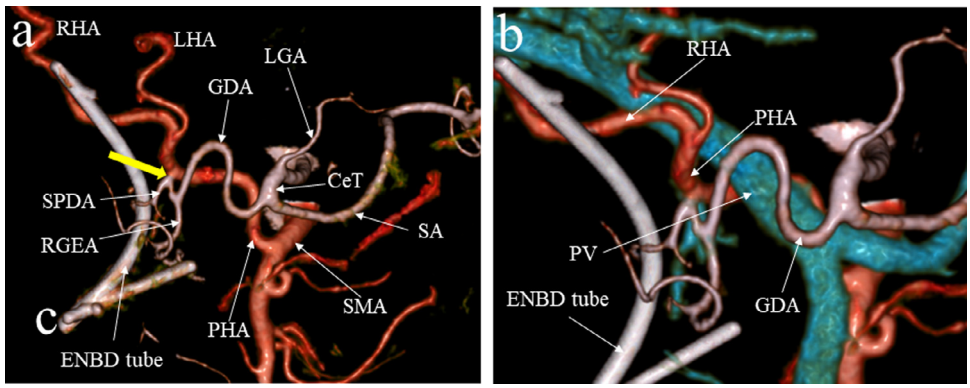

Fig. 2 – Preoperative vascular construction with 3-dimensional computed tomography. (A) CHA is absent, and the PHA is originating from the SMA. The GDA is originating from the CeT and branching into the RGEA and SPDA. A narrow communicating branch is seen between the PHA and GDA. (B) PHA and RHA are seen ascending between the common bile duct and portal vein. CeT, celiac trunk; ENBD, endoscopic nasobiliary drainage; GDA, gastroduodenal artery; LHA, left hepatic artery; LGA, left gastric artery; PHA, proper hepatic artery; PV, portal vein; RHA, right hepatic artery; SA, splenic artery; SMA, superior mesenteric artery; SPDA, superior pancreaticoduodenal artery; RGEA, right gastroepiploic artery

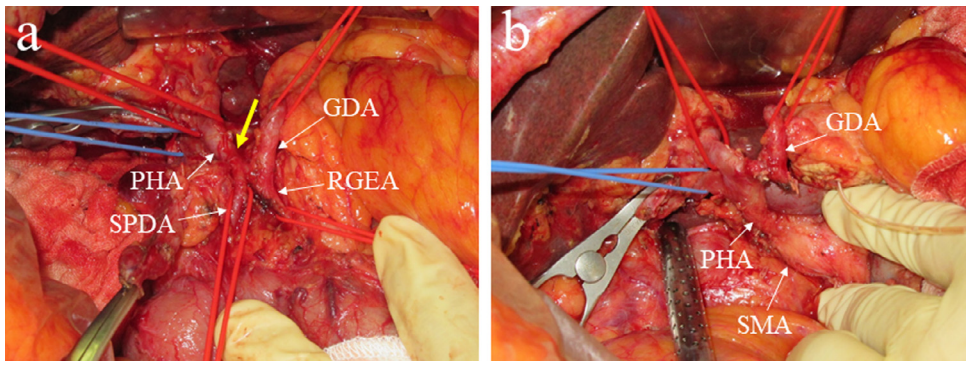

Fig. 3 – Intraoperative findings. (A) GDA is originating from the CeT and branching into the RGEA and SPDA. A narrow communicating branch is seen between the PHA and GDA (yellow arrow). (B) PHA is originating from the SMA. Both the PHA and GDA were preserved, and the RGEA and SPDA were treated individually CeT, celiac trunk; GDA, gastroduodenal artery; PHA, proper hepatic artery; RGEA, right gastroepiploic artery; SMA, superior mesenteric artery; SPDA, superior pancreaticoduodenal artery (Color version of the figure is available online.)

fied [6]. Michels divided the anatomic variations in the arterial blood supply to the liver into 10 types and reported that the frequency of the entire hepatic trunk being derived from the SMA (type IX) was 2.5%. However, this type included a normal GDA branch, and the incidence of this variation, as seen in our case is unknown [4]. Covey et al. described the classification of anatomic variations in hepatic arterial blood flow based on the results of digital subtraction angiography (DSA) performed in 600 patients. The variation wherein the PHA originated from the SMA and the GDA originated as a separate branch of the aorta was found in 2 patients (0.3%) [12]. Moreover, Song et al. described in detail the classification of celiac axis (CA) and CHA variations based on the results of spiral CT and DSA performed in 5002 patients. They defined the type of GDA originating separately without any hepatic arterial component as the absence of CHA (1.10%). There were only 5 cases (0.09%) of the PHA originating from the SMA and the GDA originating from the CeT, as observed in our case [3]. Although several other studies were referenced, the HA variations were not subdivided and the exact incidence of the same variations as in our case was unknown [5,6,13–19]. There were 2 case reports with the same arterial variants as seen in this case; however, both cases were discovered during cadaveric dissection [7,8]. We believe that this is the first report in which these arterial variants were diagnosed by preoperative diagnostic imaging, and hepatobiliary and pancreatic surgery was successfully performed.

In hepatobiliary and pancreatic surgery such as PD, an in-depth knowledge of HA anomalies is of great importance to surgeons, and can help avoid iatrogenic injuries and postoperative complications [7]. We attempted to preserve sufficient hepatic arterial blood supply so as to avoid extrahepatic ischemic complications. This can be achieved with a detailed evaluation of the anatomy of the target organ by preoperative

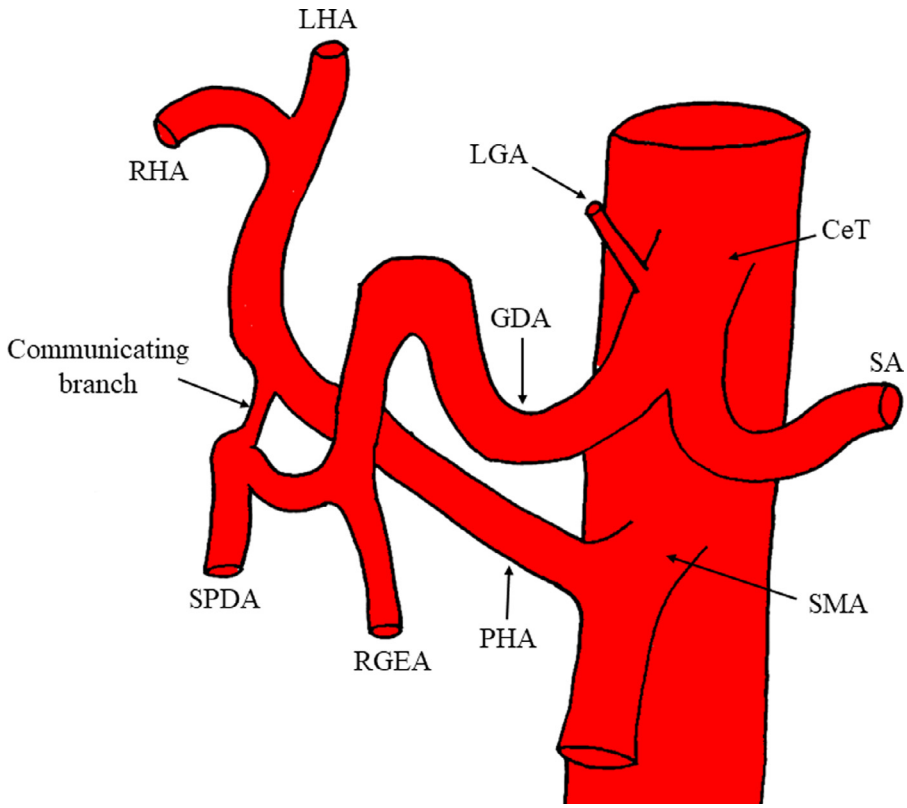

Fig. 4 – Illustration of the arterial variations in this case. CeT, celiac trunk; GDA, gastroduodenal artery; LGA, left gastric artery; LHA, left hepatic artery; PHA, proper hepatic artery; RGEA, right gastroepiploic artery; RHA, right hepatic artery; SA, splenic artery; SMA, superior mesenteric artery; SPDA, superior pancreaticoduodenal artery

diagnostic imaging [14–16,20]. Advances in multidetector CT technology have facilitated preoperative imaging evaluation of the hepatic vasculature [21,22]. In this case, 3D-CT was able to diagnose the replaced PHA and GDA preoperatively. Additionally, since the communicating branch of the PHA and GDA were known preoperatively, the RGEA and SPDA were resected instead of the GDA to maximize blood supply to the liver. By diagnosing a rare arterial variant preoperatively, we were able to perform the surgery safely.

Conclusion

We report an extremely rare case of an aberrant PHA (originating from the SMA) and an aberrant GDA (originating from the CeT) that were diagnosed by 3D-CT before hepatobiliary and pancreatic surgery. In hepatobiliary and pancreatic surgery, understanding variations in the hepatic artery before surgery is crucial to ensure optimum surgical outcomes.

Ethics approval and consent to participate

Not applicable.

Availability of data and materials

The datasets supporting the conclusions of this article are included within the article and its additional files.

Patient consent

Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.

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