A rare anastomosis between the root of common hepatic artery and proper hepatic artery: implications for pancreaticoduodenectomy

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Abstract

Background: Hepatic artery anomalies are often observed, and the variations are wide-ranging. We herein report a case of pancreatic cancer involving the common hepatic artery (CHA) that was successfully treated with pancreaticoduodenectomy (PD) without arterial reconstruction, thanks to anastomosis between the root of CHA and proper hepatic artery (PHA), which is a very rare anastomotic site.

Case presentation: A 78-year-old woman was referred to our department for the examination of a tumor in the pancreatic head. Contrast-enhanced computed tomography (CT) revealed a low-density tumor of 40 mm in diameter located in the pancreatic head. The involvement of the common hepatic artery (CHA), the root of the gastroduodenal artery (GDA), and portal vein was noted. Although such cases would usually require PD with arterial reconstruction of the CHA, it was thought that the hepatic arterial flow would be preserved by the anastomotic site between the root of the CHA and the PHA, even if the CHA was dissected without arterial reconstruction. PD with dissection of the CHA and PHA was safely completed without arterial reconstruction, and sufficient hepatic arterial flow was preserved through the anastomotic site between the CHA and PHA.

Conclusion: We presented an extremely rare case of an anastomosis between the CHA and PHA in a patient with pancreatic cancer involving the CHA. Thanks to this anastomosis, surgical resection was successfully performed with sufficient hepatic arterial flow without arterial reconstruction.

Keywords: Rare anastomosis, Pancreatic cancer, Pancreaticoduodenectomy, Arterial reconstruction

Introduction

The recent development of imaging modalities, such as three-dimensional computed tomography (CT) angiography, is helpful for better understanding vessel anomalies before surgery. Adequate knowledge of these variations would be of incredible help to the surgeon and interventional radiologist for avoiding unexpected perioperative complications and unnecessary procedures [1–3]. Hepatic artery variations, including accessory right hepatic artery branching from the gastroduodenal artery, have previously been reported [4–9]; however, to our knowledge, there are no previous reports of anastomosis between the root of the common hepatic artery (CHA) and proper hepatic artery (PHA). We herein introduce a case in which pancreaticoduodenectomy (PD) was performed without arterial reconstruction, thanks to anastomosis between the root of the CHA and PHA.

Case presentation

A 78-year-old woman was referred to our department for investigation of a tumor in the pancreatic head that was discovered upon a worsening of her diabetes. A physical examination revealed upper abdominal pain and jaundice. A laboratory analysis provided the following...
results: serum aspartate aminotransferase, 312 U/L (normal range, 13–30 U/L); alanine aminotransferase, 222 U/L (normal range, 10–42 U/L); lactate dehydrogenase, 266 U/L (normal range, 0–229 U/L); alkali-phosphatase, 3215 U/L (normal range, 0–359 U/L); γ-glutamyl transeptidase, 835 U/L (normal range, 0–132 U/L); amylase, 12 U/L (normal range, 40–126 U/L); total bilirubin, 32.5 mg/dL (normal range, 0.4–1.5 mg/dL); direct bilirubin, 23.0 mg/dL (normal range, 0.2 mg/dL); albumin, 2.4 g/dL (normal range, 4.6–6.1%); prothrombin time (PT), 14.9 s (normal range, 11.0–15.2 s); activated partial thromboplastin time, 32.0 s (normal range, 25.2–35.2 s); hemoglobin A1c, 4.9% (normal range, 4.6–6.1%); and blood glucose, 166 mg/dL (normal range, 70–109 mg/dL). The serum level of CEA was normal, but the CA19–9 level was 297.3 U/mL (normal range, < 37 U/mL).

Contrast-enhanced CT revealed a low-density tumor of 40 mm in diameter located in the pancreatic head; involvement of the CHA, the root of the gastroduodenal artery (GDA), and the portal vein (PV) was noted (Fig. 1). The preoperative diagnosis was pancreatic head cancer with the involvement of the CHA and PV, T3N1M0 stage IIb (UICC seventh edition) [10]. Although such cases would usually require PD with arterial reconstruction of the CHA, three-dimensional CT angiography revealed a very rare arterial anomaly: anastomosis between the root of the CHA and PHA (Fig. 2). It was considered that the hepatic arterial flow could be preserved if the CHA was dissected without arterial reconstruction of the CHA; thus, we planned PD and PV resection and reconstruction, without arterial reconstruction of the CHA.

During the operation, the CHA and PHA were exposed and taped. After clamping both the CHA and PHA at the dissection line with a sufficient surgical margin, the anastomotic site between the root of the CHA and the PHA became enlarged and sufficient hepatic arterial flow, almost equivalent to that before vascular clamping, was confirmed by intraoperative pulse-wave Doppler ultrasonography. The CHA and PHA were dissected and PD was safely completed with sufficient hepatic arterial flow due to anastomosis between the CHA and PHA (Fig. 3).

Histologically, as expected before surgery, the pancreatic head cancer invaded the root of the gastroduodenal artery (GDA) and PV; however, cancer cells were not invading the lumen of the GDA. The final diagnosis was pancreatic head cancer with the involvement of the CHA and PV, T3N0M0 stage IIA (UICC seventh edition) [10].

The patient did not develop any complications after surgery, including an impaired liver function or hepatic arterial flow-related complications such as biliary anastomotic leakage or stricture. Follow-up CT angiography at 3 months after surgery revealed sufficient hepatic flow through the anastomotic site between the CHA and PHA (Fig. 4). This patient developed recurrence at multiple sites in the liver 7 months after surgery and died of disease progression at 8 months after surgery.

**Discussion**

Some previous studies have reported that hepatic artery anomalies are often observed and that the variation is wide-ranging [4–9]. The recent development of imaging modalities has enabled us to understand vessel anomalies
preoperatively. A better understanding of the anatomy of vessel structures before surgery can help to avoid unexpected perioperative complications and unnecessary procedures [1–3]. Thus, adequate knowledge of these variations would be of incredible help to the surgeon and interventional radiologist [11].

Various hepatobiliary anomalies arise during the development process. During development, the coeliac axis is derived from the 10th ventral segmental artery and the superior mesenteric artery (SMA) is derived from the 13th segmental artery. The 11th and 12th segmental arteries normally regress [12, 13]. Variations occur during this development and regression of the ventral segmental arteries lead to multiple anomalies. Following normal development, the common hepatic artery usually arises as one of the three major branches of the coeliac axis. In adults, there are numerous anatomic variations of the hepatic arterial tree that result from the variable persistence of elements of the embryologic blood supply [14].

We always check the vessel structure anatomy before hepatobiliary surgery. In the present case, anastomosis between the root of the CHA and PHA was found. To the best of our knowledge, this is the first report of anastomosis between the root of the CHA and PHA that was identified prior to PD, although, it was unclear whether this developed congenitally or was acquired. Based on the observation that the pancreatic head cancer did not close the lumen of GDA histologically, it is considered that—in this case—anastomosis was congenital and arose in the development process.

In the present case, we considered that the hepatic arterial flow could be preserved if the CHA was dissected without arterial reconstruction due to anastomosis between the root of the CHA and PHA. After clamping both the CHA and PHA, sufficient hepatic arterial flow via this anastomotic site, which was almost equivalent to that before clamping, was confirmed by pulse-wave Doppler method on intraoperative ultrasonography. Although we were preparing for arterial reconstruction in the event that sufficient arterial flow could not be confirmed, the operation was successfully completed without arterial reconstruction, and the postoperative course was uneventful.

**Conclusion**

We presented an extremely rare case of an anastomosis between the CHA and PHA in a patient with pancreatic cancer involving the CHA. Thanks to this anastomosis, hepatic arterial flow was sufficiently preserved without arterial reconstruction after PD. The importance of a preoperative understanding of vessel anomalies should be emphasized.

**Abbreviations**

CHA: Common hepatic artery; CT: Computed tomography; GDA: Gastroduodenal artery; PD: Pancreatectoduodenectomy; PHA: Proper hepatic artery; PV: Portal vein

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**Authors’ contributions**

TM and KI wrote the manuscript and performed the literature search. TM, KM, KY, SI, KH, and SS treated and observed the patient. KM, KY, SI, KH, SS, and HB supervised the treatment and postoperative management. All authors read and approved the final manuscript.
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Not applicable

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Competing interests
The authors declare that they have no competing interests.

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References
1. Shukla PJ, Barreto SG, Kulkarni A, Nagarajan G, Fingerhut A. Vascular anomalies encountered during pancreatoduodenectomy: do they influence outcome? Ann Surg Oncol. 2010;17(1):186–93.
2. Yang SH, Yin YH, Jang JY, et al. Assessment of hepatic arterial anatomy in keeping with preservation of the vasculature while performing pancreatoduodenectomy: an opinion. World J Surg. 2007;31:2384–91.
3. Traverso LW, Feeney PC. Pancreaticoduodenectomy: the importance of preserving hepatic blood flow to prevent biliary fistula. Am Surg. 1989;55:421–6.
4. Michels NA. Newer anatomy of the liver and its variant blood supply and collateral circulation. Am J Surg. 1966;112:337–47.
5. Adachi B: Das Arteriensystem der Japaner. 2nd, Kenkyusya, Tokyo, 1928, p11–68.
6. Hiatt JR, Gabbay J, Busuttil RW. Surgical anatomy of the hepatic arteries in 1000 cases. Ann Surg. 1994;220(1):50–2.
7. Fonseca-Neto OCLD. Anatomic variations of hepatic artery: a study in 479 liver transplantations. Arq Bras Cir Dig. 2017;30(1):35–7.
8. Kobayashi S, Otsubo T, Koizumi S, Arizumi S, Katagiri S, Watanabe T, et al. Anatomic variations of hepatic artery and new clinical classification based on abdominal angiographic images of 1200 cases. Hepato Gastroenterology. 2014;61:2337–40.
9. Zagyapan R, Kurkcuoglu A, Bayraktar A, Pelin C, Aytekin C. Anatomic variations of the celiac trunk and hepatic arterial system with digital subtraction angiography. Turkish J Gastroenterol. 2015;25:104–9.
10. UICC. TNM classification of malignant Tumours. In: Sobin LH, Gospodarowicz MK, Wittekind C, editors. . 7th ed: Wiley Blackwell; 2009.
11. Egorov VI, Yashina NI, Fedorov AV, Karmazanovsky GG, Vishnevsky VA, Schevchenko TV. Cellaco-mesenterial arterial aberrations in patients undergoing extended pancreatic resections: correlation of CT angiography with findings at surgery. JOP. 2010;11(4):348–57.
12. Nebesar RA, Kombrith PL, Pollard JJ, Michels NA. Celiac and superior mesenteric arteries. Boston: Little & Brown; 1969. p. 667–73.
13. Sadler TW. Langman’s medical embryology; 1985. p. 196–205.
14. Kadir S, editor. Atlas of normal and variant angiographic anatomy: WB Saunders Company; 1991. p. 503–24.