The Absence of a Proper Hepatic Artery: A Case Report

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Patient: Female, 80-year-old
Final Diagnosis: Lung adenocarcinoma
Symptoms: Death
Medication: —
Clinical Procedure: —
Specialty: Anatomy • Surgery

Objective: Unusual clinical course

Background: Pancreaticoduodenectomy, liver transplantation, cholecystectomy, and surgical management of traumatic injuries are all dependent on in-depth knowledge of the anatomy of the common hepatic artery and its subsequent divisions. The common hepatic artery arises from the celiac trunk, which is the first major branch of the abdominal aorta. The common hepatic artery bifurcates into the gastroduodenal artery traveling inferiorly behind the duodenal bulb and the proper hepatic artery continues laterally toward the liver within the hepatoduodenal ligament. The proper hepatic artery provides the right gastric artery before dividing into the left and right hepatic arteries. Anatomical variations in the common hepatic artery and its subdivisions are common and this case report identifies a seemingly undocumented novel variation.

Case Report: 80-year-old female donor who died of lung adenocarcinoma presented with an anatomical variation of the common hepatic artery discovered during necropsy. The donor had a common hepatic artery that gave rise to the left hepatic artery, then continued until it bifurcated into the gastroduodenal artery and right hepatic artery. The cystic artery originated from the left hepatic artery, traveling anteriorly over the bile duct and portal vein. The donor seems to have no proper hepatic artery and instead had a novel variation of the common hepatic artery.

Conclusions: The observation of this variation underscores the importance of not only being familiar with the standard anatomy but also for variations that can occur. It also furthers support of the standard of preoperative imaging for surgical patients to help identify and prepare for variations.

Keywords: Hepatic Artery • Anatomic Variation • Vascular Malformations • Vascular Surgical Procedures

Abbreviations: CA – cystic artery; LHA – left hepatic artery; RGA – right gastric artery; CHA – common hepatic artery; GDA – gastroduodenal artery; HPV – hepatic portal vein; RGA – right gastroepiploic artery; ASPA – anterior superior pancreaticoduodenal artery; RHA – right hepatic artery; BD – bile duct; SDA – superior duodenal artery; PHA – proper hepatic artery; AA – abdominal aorta

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**Background**

The first major vessel coming off the abdominal aorta is the celiac trunk, which trifurcates into 3 vessels – the splenic artery, left gastric artery, and the common hepatic artery [1-3]. The common hepatic artery travels to the right of the abdominal aorta and provides a vessel known as the gastroduodenal artery traveling inferiorly behind the duodenal bulb, which further subdivides into the anterior and posterior superior pancreaticoduodenal artery and the right gastro-omental (gastro-epiploic) artery [1-3]. These arteries supply the stomach, duodenum, and pancreas. After giving rise to the gastroduodenal artery, the common hepatic artery travels within the hepatoduodenal ligament and is now referred to as the proper hepatic artery. The proper hepatic artery further divides into the left hepatic artery and right hepatic artery [1-3]. As the name indicates, these blood vessels supply the liver with blood. The right hepatic artery often gives rise to the cystic artery that supplies the gallbladder. The description of the typical anatomy observed in this region of the body can be seen in Figure 1.

Traumatic injuries that require repair via an open laparotomy [4] or interventional radiologic procedure [5], liver transplantation [6], cholecystectomy [7], and pancreatoduodenectomy [8] are all operations that rely on physicians having an intimate knowledge of the common hepatic artery and its branches. However, that vasculature is rife with variations that can further complicate these intricate procedures (Figure 2).

**Case Report**

This case report originates from the dissection of an 80-year-old woman who donated her body to the University of Toledo College of Medicine and Life Sciences. Little is known of her past medical history due to the anonymous nature of the donation program. It is known that she died from complications of lung adenocarcinoma. Upon dissection, the donor had a normal appearing celiac trunk with a common hepatic artery branching off it and traveling laterally to the right. The common hepatic artery measured approximately 38 mm from the celiac truck to the gastroduodenal artery. The left hepatic artery, measuring 31 mm, is the first vessel observed originating from the common hepatic artery. Before it enters the liver, the cystic artery branches off (Figure 3). The cystic artery, measuring 17 mm, travels anteriorly over the portal vein, and bile duct. The unnamed vessel continues laterally until it bifurcates into the gastroduodenal artery and the right hepatic artery, measuring 41 mm (Figure 4). This is of interest because the proper hepatic artery is typically identified as the continuation of the common hepatic artery after the gastroduodenal artery branches off it (Figure 1) [1]. Since the gastroduodenal artery and right hepatic artery bifurcate after the left hepatic artery leaves the common vessels, it appears the donor does not have a conventional proper hepatic artery. The liver itself did not have any visible abnormalities and did not appear diseased, indicating that this anomaly was compatible with normal liver function and life.

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**Figure 1.** The typical vasculature of the common hepatic artery based on Gray’s Anatomy description [3].

**Figure 2.** Abnormal anatomy observed in the donor patient.
Discussion

There are many documented variations of the hepatic vasculature, but several case reports have recently highlighted previously unidentified variations. Starting at the celiac trunk, Elsamaloty et al [9] reported a case from a cadaver dissection where 3 hepatic arteries supplied the liver. The right hepatic artery arose directly from the abdominal aorta, creating a “quadrification” of the celiac trunk. Hicks et al [10] published a case report where a patient did not have a typical celiac trunk. The patient had a splenic vessel that branched off the abdominal aorta, and inferior to that the common hepatic artery and superior mesenteric artery branched off the abdominal aorta. A similar occurrence was observed by Jablonska et al [11] in 77-year-old women. The patient had no celiac trunk but rather had a common hepatic artery, left gastric artery, and splenic artery that arose from separate locations on the abdominal aorta. The variants reported by Hicks et al and Jablonska et al were significant because they were identified in living patients. Both patients received preoperative imaging prior to their pancreaticoduodenectomy. Their individual variants were then accounted for in the surgical planning. During a pancreaticoduodenectomy, identification of the origin and branching of the gastroduodenal artery and cystic artery are key parts of the operation [8]. This procedure is often done when there is pancreatic cancer and knowing the vasculature is important to help identify lymph nodes that also must be biopsied and or excised in the case of malignancy [12]. The hepatic artery lymphoid is one of these crucial lymph nodes because it can indicate metastasis to the liver [12].

Due to the frequency of observed variations in hepatic vasculature, Dr. Michels described 10 commonly encountered hepatic artery varieties in a 1966 publication [13]. A 2021 analysis of 5625 imaging studies of patients to understand variations in the hepatic artery found that in 15.6% of cases there was an aberrant right hepatic artery and 16.3% had an aberrant left hepatic artery [14]. A large literature/case review by Nissious et al [15] gives a better idea of the frequency of variations, and their findings are summarized in Table 1.

Table 1. This table reflects the results from the Nissious et al review [15].

| Type of variant | Percentage of patients with it (n=19 031) |
|-----------------|------------------------------------------|
| Variation from normal anatomy | 20.0%                                    |
| Unreported/unclassified anomalies | 4.1%                                     |
| Replaced right hepatic artery arising from the superior mesenteric artery | 3.7%                                     |
| Replaced left hepatic artery arising from the left gastric artery | 3.0%                                     |
| Accessory left hepatic artery | 3.2%                                     |
| Accessory right hepatic artery | 1.6%                                     |
| Common hepatic originating from the superior mesenteric artery | 1.2%                                     |

While patients may have a normal appearing celiac trunk, the route and branches of the common hepatic artery can be atypical. This can cause complications for surgeons during operations if not planned for. It is estimated that 7000 liver transplants occur each year in the United States of America [16].
Knowledge of hepatic vasculature and associated lymphatics along with variants are essential for hepatectomy, the formation of proper anastomosis with the recipient’s vasculature, and, ultimately, patient outcomes [6,17]. The study of liver lymphatics and its role not only in hepatic disease but also in transplantation is an area in need of much research and discovery. Koops et al looked at 605 celiac and superior mesenteric angiographs of patients with various liver pathology. They observed that approximate 20% of patients had some type of hepatic artery variation [18]. Interestingly, Badagabettu et al [19] published a cadaver case report of common hepatic anatomy that shared similarities to our donor anatomy. Their patient had a common hepatic artery that trifurcated into the right hepatic artery, left hepatic artery, and the gastroduodenal artery. Their patient, similar to ours, appeared not to have a proper hepatic artery. Emergent exploratory laparotomies for traumatic injuries and liver transplantation both require a large abdominal incision [4,6]. This large incision allows the surgeon to visualize the whole anatomy and possible variants. This is an advantage not present when laparoscopic and interventional radiologic procedures are performed.

Laparoscopic and minimally invasive robotic-assisted surgeries have become increasingly common. It is estimated that 750,000 laparoscopic cholecystectomies occur per year in the United States [7]. Sheetz et al [20] published a paper in 2020 indicating that the proportion of robotic-assisted surgeries increased from 1.8% to 15.1% of surgical cases. Any minimally invasive surgery is going to offer a limited view of the patient’s anatomy, which makes preoperative imaging essential for identification of anatomy and potential variations. Laparoscopic and robotic-assisted cholecystectomy require identification and ligation of the cystic artery and duct [7]. The cystic artery, which supplies the gallbladder, typical arises from the right hepatic artery, but in 21% of cases, it originates from another vessel [21]. In the study cited above, 17.9% of cystic arteries were found anterior to the bile duct [21], similar to our donor’s anatomy (Figures 1, 4).

Interventional radiologic procedures rely on using imaging modalities to guide catheters through vessels to reach the target tissue where medication, dye, embolization, or drainage can be utilized [22]. Interventional radiologic procedures are becoming more common in the management of liver transplant [23], emergent general surgery, and trauma patients [24,25]. Since interventional radiologists rely on traveling through vasculature, preoperative and intraoperative imaging is vital to visualize the anatomy and plan appropriately for any anomalies encountered.

Conclusions

We discussed various hepatic vascular anomalies both common and uncommon and their potential for clinical impact. While 1 case report was found where a patient did not have a proper hepatic artery due to a trifurcation of the common hepatic, their vasculature did match our novel finding. While this undocumented variant did not seem to impact our donor’s life or liver, it does underscore the need for surgeons and interventional radiologists to have a firm grasp on both typical and atypical anatomy. It may be time for another large literature review to help identify the frequency of new hepatic vascular anomalies.

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Declaration of Figures’ Authenticity

All figures submitted have been created by the authors who confirm that the images are original with no duplication and have not been previously published in whole or in part.

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