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Case Report

Replaced Right Hepatic Artery Originating from the Common Hepatic Artery: A Case Report

Aqsa Shakoor* *and Beth Schrope*

Department of Surgery, NewYork-Presbyterian Hospital, Columbia University Medical Center, New York, USA

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ABSTRACT

The presence of an aberrant right hepatic artery is the most frequently encountered vascular anomaly during pancreaticoduodenectomy, and its recognition and preservation are of paramount importance to prevent ischemia of the bile duct and consequently the bilioenteric anastomosis, which can lead to anastomotic leak or dehiscence and fistula. In this case report, we describe proximal branching of the common hepatic artery (CHA) to give rise to a replaced right hepatic artery (RHA), which courses posterior to the portal vein (PV) and common bile duct (CBD) to the right lobe of the liver. The location of this replaced RHA in the hepatoduodenal ligament is consistent with the location of a replaced RHA described by the Michels classification, although with the important distinction that origin was the CHA instead of the superior mesenteric artery (SMA). From our review of the current literature, this is the first published description of such an anatomic course of the RHA.

Introduction

Recognition of anatomical variations of hepatic arteries is essential in the planning and execution of safe hepatobiliary operations. One of the most widely used classification schemes and the benchmark for the description of hepatic arterial anatomy is the Michel's classification [1]. Published in 1966, he describes ten commonly observed anatomic variations in the hepatic arterial blood supply based on the results of 200 cadaveric dissections. This was further modified in 1994 by Hiatt, who examined 1000 cases of donor livers used for orthotopic transplantation and classified the hepatic arterial findings into six types [2]. In addition to these two milestone publications, there have been a plethora of papers to describe additional variations and their surgical significance.

The "typical" anatomical course of a right hepatic artery (RHA) is one that originates from the proper hepatic artery (PHA), crosses anterior to the portal vein (PV) from left to right and passes behind the common hepatic duct (CHD) to enter Calot's triangle where it gives origin to the cystic artery and then continues cephalad behind the right hepatic duct to enter the right lobe of the liver. We define an aberrant right hepatic artery (ARHA) as one whose anatomic course deviates from the one described above or whose origin is one other than the PHA. An ARHA includes both replaced and accessory arteries. A replaced artery is one that substitutes for the normal artery described above, while an accessory artery exists in addition to the normal present artery.

In this case report, we describe a replaced RHA branching proximally from the CHA and coursing under the PV and CHD and terminating in the right lobe of the liver. The gastroduodenal artery (GDA), typically defined as the terminal branch of the common hepatic artery (CHA), was observed to be in its appropriate anatomic location and origin. From our review of the current literature, and to the best of our knowledge, this is the first such published anatomical description of such an anatomic course of the RHA.

**Correspondence to: Aqsa Shakoor, M.D., Columbia University Medical Center, Department of Surgery, 177 Fort Washington Avenue, 7GS-313, New York 10032, USA; Tel: 5853549069; E-mail: aqsa.shakoor@gmail.com*

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Case Report

The patient is an 83-year-old female with coronary artery disease and hypertension who presented with elevated liver function tests with work-up revealing intra- and extra-hepatic biliary ductal dilation secondary to an obstructing mass in the head of the pancreas measuring 3.2 x 3.8 x 3.1 cm. Fine needle aspiration of the lesion revealed a well-differentiated adenocarcinoma with mucinous features. The lesion was deemed resectable, and the patient was scheduled to undergo a pancreaticoduodenectomy.

Diagnostic laparoscopy confirmed the absence of metastatic lesions in the peritoneal cavity and liver surface. A vertical upper midline incision was made, and the peritoneal cavity was sharply entered. The hepatic flexure of the colon was mobilized, and a wide Kocher maneuver performed. Next, the hepatoduodenal ligament was opened with findings of aberrant arterial anatomy. A large lymph node basin adjacent to the hepatic artery was resected, and the GDA traveling caudally was identified. An arterial vessel was noted to be coursing posterior to the portal vein and the CBD (Figure 1). On proximal exposure of the vessel, it was a branch of the CHA, and on distal exposure, it was coursing cephalad to the right lobe of the liver, confirming it as the RHA. An intraoperative doppler device was used to confirm an arterial signal.

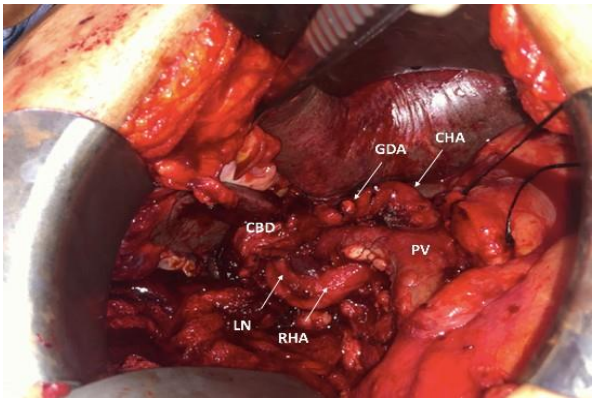

Figure 1: Intra-operative picture of anatomy. CHA: common hepatic artery; GDA: gastrodudodenal artery; PV: portal vein; RHA: right hepatic artery; LN: adherent lymph node to RHA; CBD - common bile duct.

Upon safe identification of the vasculature, the GDA was test clamped to ascertain that it did not provide retrograde blood flow to the liver due to possible proximal celiac occlusion or stenosis. With no change in PHA pulse after the test clamp of the GDA, it was ligated. The portal venous tunnel under the neck of the pancreas was completed, followed by transection of the jejunum and subsequently the gastric antrum with ligation and division of the bowel mesentery. Next, the CBD was divided, followed by the neck of the pancreas. The tumor was adherent to the SMV-PV confluence requiring removal of a small piece of the vein with primary reconstruction. The tumor was removed with negative margins on frozen pathology.

The peritoneal defect from the duodenal resection was closed, and the jejunum was brought up in a retrocolic fashion. End-to-side pancreaticojejunostomy in duct-to-mucosa fashion, end-to-side hepaticojejunostomy, and gastrojejunostomy were performed. A Blake drain was placed around the anastomoses, and the abdomen was closed. The patient has an uneventful post-operative course and was discharged home on post-operative day 7.

Discussion

The implications of an inadvertent injury to an aberrant RHA, especially a replaced artery, include severe short- and long-term ramifications for patients. Hence, a thorough understanding of anatomy and possible variations in its course and origin is critical for surgeons.

The “typical” anatomical course of the RHA is illustrated in (Figure 2). The CHA gives off the GDA, becoming the PHA, which then bifurcates in the LHA and RHA. The RHA then crosses anterior to the PV, passing behind the CHD and continuing cephalad to the supply of the right liver. In comparison, the findings in our patient are illustrated in (Figure 3). The CHA runs only a short distance before supplying the RHA branch, which courses posterior to the PV and continues cephalad behind the CHD to supply the right liver. After the RHA branches off, the CHA gives off the GDA and then continues cephalad to become the LHA. Because of the early take-off of the RHA and the short distance between the GDA and LHA, there is no discernable PHA.

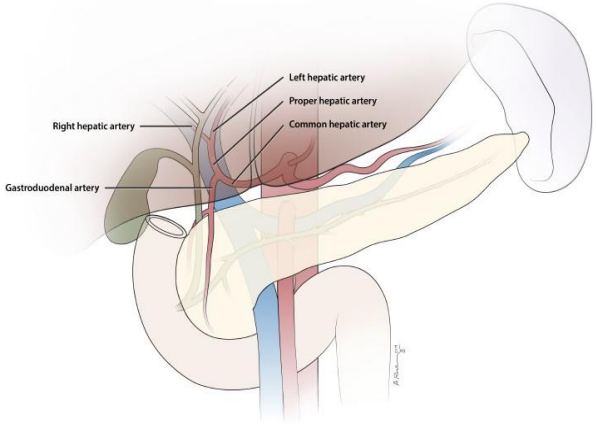

Figure 2: Illustration of normal anatomy.

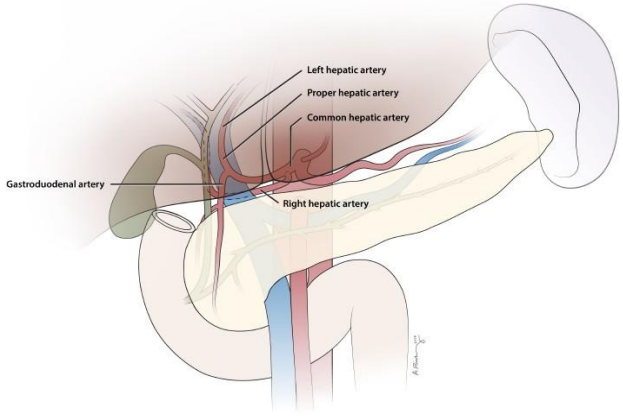

Figure 3: Illustration of intraoperative aberrant hepatic arterial anatomy.

The location of the RHA, dorsal to the portal vein, in the hepatoduodenal ligament described in our patient, is consistent with the location of an ARHA arising from the SMA as observed by Michels *et al*. [1]. Michels described the course of an ARHA arising from the SMA, coursing upward from left to right and dorsal to the pancreas, portal vein, and CHD to reach Calot’s triangle. During the routine performance of a PD

procedure, it is standard to palpate for a pulse posterior to the portal vein in the foramen of Winslow, to assess for a replaced RHA. Indeed, during this surgery, we were able to both palpate a strong pulse but also confirm with Doppler for the presence of an artery. The main difference, of course, between the Michels description and ours is that we found the RHA to be arising from the CHA instead of SMA.

The incidence of an ARHA, whether replaced or accessory, is difficult to ascertain as the published number in any given study varies on the number of cases examined. Liang *et al*. conducted a systematic review of 21 articles and 16 case reports that encompassed 10,966 cases. Of these, only 7,365 (67.2%) of cases had the standard anatomy described above [3]. An accessory RHA was identified in 748 (6.8%) of cases and a replaced RHA in 1,069 (9.7%) of cases. As confirmed by the current literature, the course of an RHA appears to be rather plastic. Numerous case report studies describe the RHA traveling through the pancreatic parenchyma, traveling anterior to the common bile duct (CBD), crossing anterior to the common hepatic duct (CHD) subsequently causing a CHD stricture, or coursing anterior to the infundibulum and fundus of the gallbladder, amongst others. Similarly, variations in the source of origin include an RHA arising from the SMA, celiac trunk, aorta, left gastric artery (LGA), and right renal artery [1, 4-10].

The presence of an ARHA is the most frequently encountered vascular anomaly during a pancreaticoduodenectomy (PD) surgery, found in nearly one in five patients undergoing a pancreatic resection [11, 12]. The lone presence of an aberrant RHA does not affect the resectability of pancreatic cancer or rates of R1 resection and overall survival. During an 11-year retrospective study, Kim *et al.* examined 289 patients scheduled to undergo PD of whom 37 had an aberrant RHA [13]. While the operative time and median estimated blood loss was higher in the aberrant RHA group compared to the standard anatomy group (479 ± 85 min vs. 439 ± 128 min and 950 mL vs. 650 mL, respectively), this was not found to be statistically significant (p=0.05 and p=0.5, respectively). With respect to oncologic outcomes, the rates of positive margin (R1 resection) and median survival were also not found to be statistically significant. Similarly, Turrini *et al.* reported no increase in post-operative morbidity and or rate of positive margins in patients with aberrant RHA undergoing PD for pancreatic adenocarcinoma [14].

While these findings are reassuring, the emphasis to identify and preserve an aberrant RHA should still be stressed as an inadvertent injury to it can result in bilioenteric anastomosis breakdown or formation of a bile fistula [15, 16]. The arterial blood supply of the supraduodenal bile ducts arises from the GDA and its branch, the retroduodenal artery, and the RHA and its branch, the cystic artery [17]. In a traditional PD, the cystic artery, GDA and subsequently its branch of the retroduodenal artery are all ligated. Any inadvertent injury to the remaining blood supply provided by the RHA carries a risk of ischemia to the bile duct remnant.

Conclusion

In summary, the presence of an aberrant RHA is a common finding, encountered in up to 33% of the population and is one of the most frequently encountered vascular anomalies during a pancreaticoduodenectomy. Its prompt identification and conservation are essential to prevent life-threatening complications in patients, and hence a thorough understanding of anatomy is essential for all general and hepatobiliary surgeons.

Consent

Written informed consent was obtained from the patient for publication of this case report and all accompanying images.

Funding

None.

Conflicts of Interest

None

REFERENCES

1. N A Michels (1996) Newer anatomy of the liver and its variant blood supply and collateral circulation. *Am J Surg* 112: 337-347. [Crossref]
2. J R Hiatt, J Gabbay, R W Busuttil (1994) Surgical anatomy of the hepatic arteries in 1000 cases. *Ann Surg* 220: 50-52. [Crossref]
3. Yiming Liang, Enliang Li, Jiaqi Min, Chengwu Gong, Linquan Wu (2017) Rare anatomic variation of the right hepatic artery and accessory right hepatic artery supplying hepatocellular carcinoma: A case report and literature review. *Medicine* 96: e8144. [Crossref]
4. L Rebibo, J Peltier, O Gerin, D Michel, B Robert et al. (2014) Unusual course of the aberrant right hepatic artery running through the pancreatic parenchyma during modified Frey's procedure. *Morphologie* 98: 182-186. [Crossref]
5. Satoru Honma, Wakoto Matsuda, Motoi Kudo (2013) Right hepatic artery traveling anteriorly to the common bile duct. *Anat Sci Int* 88: 93-96. [Crossref]
6. Aureen D'Cunha, B S S Ravi Kishore, Isaac Tharu Varghese (2018) A Rare Case of a Common Hepatic Duct Stricture Secondary to an Anteriorly Crossing Right Hepatic Artery in an Infant. *J Indian Assoc Pediatr Surg* 23: 161-163. [Crossref]
7. Matthew J Blecha, Angela R Frank, Todd A Worley, Francis J Podbielski (2006) Aberrant right hepatic artery in laparoscopic cholecystectomy. *JSLS* 10: 511-513. [Crossref]
8. Hideki Katagiri, Takashi Sakamoto, Kenji Okumura, Alan Kawarai Lefor, Tadao Kubota (2016) Aberrant right hepatic artery arising from the celiac trunk: A potential pitfall during laparoscopic cholecystectomy. *Asian J Endosc Surg* 9: 72-74. [Crossref]
9. Eleni Panagouli, D Venieratos (2011) Right accessory hepatic artery arising from the left gastric artery: a case report. *Rom J Morphol Embryol* 52: 1143-1145. [Crossref]
10. Lal Darsan, Vaibhav Vishal, Felix Cardoza (2019) Accessory right hepatic artery originating from proximal and distal right renal artery in two subjects. *Indian J Urol* 35: 305-306. [Crossref]
11. Ashwin Rammohan, Ravichandran Palaniappan, Anbalagan Pitchaimuthu, Kamalakannan Rajendran, Senthil Kumar Perumal et al. (2014) Implications of the presence of an aberrant right hepatic artery in patients undergoing pancreaticoduodenectomy. *World J Gastrointest Surg* 6: 9-13. [Crossref]
12. John A Stauffer, Mellena D Bridges, Naciye Turan, Justin H Nguyen, J Kirk Martin (2009) Aberrant right hepatic arterial anatomy and

pancreaticoduodenectomy: recognition, prevalence and management. *HPB(Oxford)* 11: 161-165. [Crossref]

13. Peter T W Kim, Sara Temple, Eshetu G Atenafu, Sean P Cleary, Carol Anne Moulton et al. (2014) Aberrant right hepatic artery in pancreaticoduodenectomy for adenocarcinoma: impact on resectability and postoperative outcomes. *HPB(Oxford)* 16: 204-211. [Crossref]
14. Olivıer Turrini, Eric A Wiebke, Jean Robert Delpero, Frédéric Viret, Keith D Lillemoe et al. (2010) Preservation of replaced or accessory right hepatic artery during pancreaticoduodenectomy for adenocarcinoma: impact on margin status and survival. *J Gastrointest Surg* 14: 1813-1819. [Crossref]
15. L W Traverso, P C Freeny (1989) Pancreaticoduodenectomy. The importance of preserving hepatic blood flow to prevent biliary fistula. *Am Surg* 55: 421-426. [Crossref]
16. M S Woods, L W Traverso (1993) Sparing a replaced common hepatic artery during pancreaticoduodenectomy. *Am Surg* 59: 719-21. [Crossref]
17. Denis Castaing (2008) Surgical anatomy of the biliary tract. *HPB(Oxford)* 10: 72-76. [Crossref]