

Complex pattern of a variant hepatic artery

*Khin Pa Pa Hlaing*¹, MBBS, MMedSc, *Faizah Othman*¹, MD, PhD

ABSTRACT Liver transplantation is the only solution for end-stage liver diseases. The common hepatic artery (CHA) arises from the coeliac trunk (CT), and the right (RHA) and left hepatic (LHA) arteries are its terminal branches. An abnormal arterial pattern would influence the surgical outcome. The anterior layer of the lesser omentum of a female cadaver was cleaned to identify the CHA, which was traced backwards for its origin and toward the porta hepatis for its terminal branches. In this case, the replaced RHA originated from the CT and ran posterior to the portal vein and the common bile duct. The replaced LHA arose from the left gastric artery. The CHA originated from the CT and branched out as the middle hepatic and gastroduodenal arteries. The replaced RHA and LHA with alteration in relation to the neighbouring structures is a complex and rare variant. Knowledge of this uncommon arterial anomaly is beneficial for hepatobiliary surgeons.

Keywords: arteries, hepatic artery, hepatic duct, liver
Singapore Med J 2012; 53(9): e186–e188

INTRODUCTION

The liver is susceptible to various injuries and diseases. The treatment for late-stage liver disease is whole or partial liver transplantation. Furthermore, arterial chemoembolisation is a treatment option for inoperable liver tumours. Knowledge of hepatic arterial variations is necessary for surgical procedures. The common hepatic artery (CHA) normally originates from the coeliac trunk (CT) and supplies the liver with right (RHA) and left hepatic arteries (LHA) at the respective lobes. The classical hepatic arterial pattern has been observed in 55%–70% of cases by different researchers.^(1–4)

As stated in most textbooks of anatomy, the hepatic artery lies medial to the common hepatic duct. During cholecystectomy, the hepatic artery is more vulnerable to injuries compared to the hepatic ducts, even in classic anatomical relation.⁽⁵⁾ Therefore, understanding of the hepatic arterial anatomy and its variants is essential in order to ensure successful outcomes in surgical and radiological interventions. We report a case of aberrant pattern of the hepatic artery and discuss its clinical implications.

CASE REPORT

During routine anatomical dissection of the abdominal region of a female cadaver for the teaching of second year medical students, the anterior layer of the lesser omentum was carefully dissected to demonstrate the hepatic artery and its relation to the surrounding structures. The hepatic artery was then traced proximally to identify its origin, and distally toward the porta hepatis to identify its terminal branches. The age and background medical history of the subject was not obtained for any correlated study.

It was found that the CHA originated from the CT, as in classical anatomy. However, it terminated 3 cm away from the point of origin as the gastroduodenal artery and the middle

hepatic artery (MHA). The MHA ran lateral to the caudate process of the liver and entered the liver substance at the fissure between the right and left lobes. The MHA traversed anterior to the portal vein (PV) and medial to the common bile duct (CBD). There was no terminal branch from the CHA supplying the right and left lobes of the liver.

However, the RHA and LHA were found to arise independently from different origins. While tracing the arteries to their origins, we found that the RHA took origin from the root of the CT, prior to the origins of the normal branches such as the CHA, and the left gastric artery (LGA) and splenic artery. Meanwhile, the LHA originated from the LGA, arising 2.5 cm from the exit point of the LGA. Both the RHA and LHA were considered as replaced arteries, and were the sole arterial supplies to the right and left lobes of the liver, respectively. The replaced RHA initially ran posterior to the PV and the CBD, and took a course between the PV and CBD. It then traversed posterior to the CBD and passed anterior to the neck of the gallbladder before entering the right lobe of the liver. The LHA entered the liver through the fissure between the caudate process and the left lobe of the liver (Fig. 1).

DISCUSSION

In standard anatomy texts, the CHA originates from the CT and gives rise to the right gastric and gastroduodenal arteries. The RHA and LHA are the terminal branches of the CHA. The CHA and its branches lie within the hepatoduodenal ligament, the CBD lies lateral to the CHA, and the PV lies posterior to the CHA.^(6–8)

In hepatic arterial anatomy, variant arteries are found in more than one-third of all cases. An aberrant artery is defined as an accessory artery existing together with the normal artery and a replaced artery, which is the sole arterial supply.⁽¹⁾ In Michels'

¹Department Of Anatomy, Faculty of Medicine, Universiti Kebangsaan Malaysia, Kuala Lumpur, Malaysia

Correspondence: Dr Khin Pa Pa Hlaing@Farida Hussan, Senior Lecturer, Anatomy Department, Faculty of Medicine, Universiti Kebangsaan Malaysia, Jalan Raja Muda Abdul Aziz, 50300 Kuala Lumpur, Malaysia. khinpapah@gmail.com

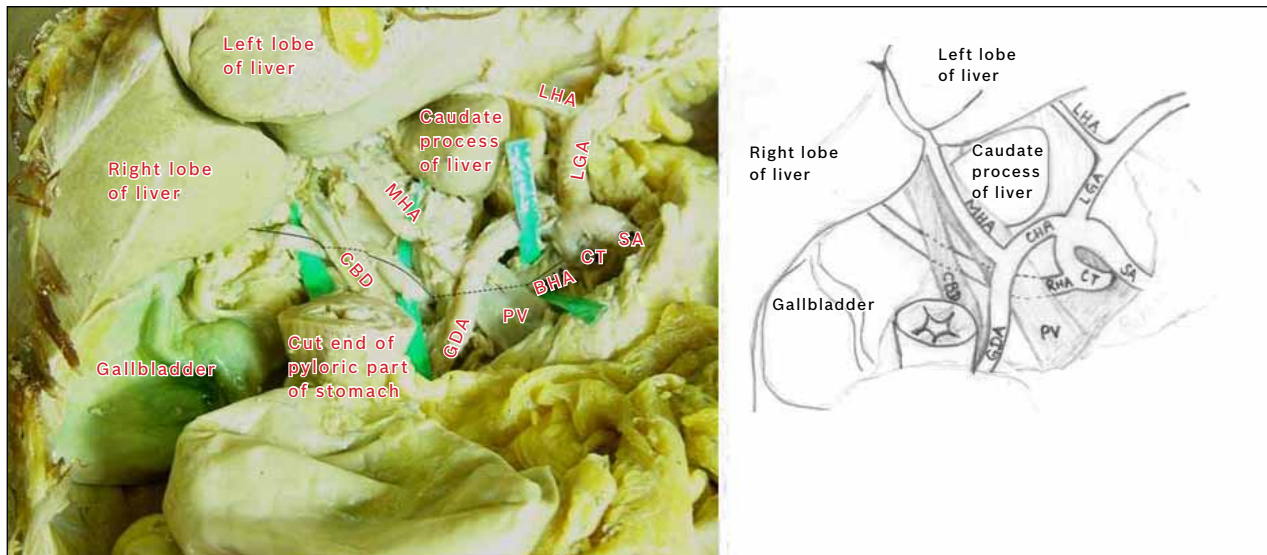


Fig. 1 Photograph and illustration show the complex pattern of a variant hepatic artery.

CBD: common bile duct; CHA: common hepatic artery; CT: coeliac trunk; GDA: gastroduodenal artery; LGA: left gastric artery; LHA: left hepatic artery; MHA: middle hepatic artery; PV: portal vein; RHA: right hepatic artery; SA: splenic artery

classification, a replaced LHA alone is categorised as Type II, while a replaced RHA alone is Type III. Moreover, if both the RHA and LHA are replaced arteries, they are considered as Type IV variants. The Type IV variant was found in 1% of 200 cases,⁽¹⁾ 2.3% of 1,000 cases and 3.1% of 1,081 specimens.^(2,4) However, previous studies found that the replaced RHA and LHA arose from the superior mesenteric artery and LGA, respectively.^(1,2,4) Convey et al reported that the incidence of RHA originating from the CT was one in 601 cases; however, this was an accessory artery.⁽³⁾ In the present case, the replaced RHA originated from the CT and the replaced LHA originated from the LGA, which, to the best of our knowledge, has not been mentioned in previous studies. In this case, the anomalous origin of the RHA did not fall into any of the previously classified categories.

Injury or ligation of a replaced artery during an operation would deprive the corresponding lobe of blood supply. Since 1923, several studies have shown that no evidence of arterial anastomosis can be found within the livers of cadavers.⁽⁹⁾ Therefore, the hepatic artery is considered as an end artery, and this has been proven in cadaveric studies.⁽⁹⁾ However, an arteriographic study in living subjects revealed that there was no compromised blood flow to the liver although one artery was ligated. This could be attributed to the neurohumoral factors that play a role in opening up the existing collateral arteries.⁽⁹⁾ The response to these factors may vary individually. Therefore, medical professionals still adhere to the concept that ligation of the hepatic artery might lead to ischaemia of that particular region of the liver. Applying this concept, the selective transarterial chemoembolisation method was developed to treat metastatic tumours of the liver.

In transplant surgery, arterial reconstruction is mandatory for all methods of transplantation, including living donor, split liver transplantation. Arterial anomaly influences the outcome of arterial reconstruction. Graft with aberrant arteries requires

complex arterial reconstruction to revascularise the graft.⁽¹⁰⁾ Hepatic arterial thrombosis is one of the fatal complications following complex arterial reconstruction.⁽¹⁰⁾ However, the presence of replaced arteries is favourable for arterial anastomosis in split liver or lobectomy in living donors due to their size and independent origins.⁽⁴⁾ In the present case, both the RHA and LHA arose independently from the CT and LGA, but the diameters of the arteries were not determined for the present study.

In the portal triad, the hepatic artery lies medial to the common hepatic duct. The RHA passes anterior to the hepatic duct before entering the liver.^(6,7) During cholecystectomy, arterial injury usually occurs during hepatic and cystic duct exploration, even in classical anatomy of the portal triad.⁽⁵⁾ In the present study, the replaced RHA traversed posterior to the portal vein and the CBD, but crossed anterior to the neck of the gallbladder just before entering the liver substance. The difficulty in identification of the artery would be one of the predisposing factors to inadvertent arterial injury. The alteration in the relation of the aberrant artery to its neighbouring structures is one of the trigger factors of iatrogenic injury, especially during laparoscopic surgery.

In conclusion, knowledge of the variant hepatic artery and its altered relation to the neighbouring structures would be beneficial in hepatobiliary surgery. Anatomists and pathologists should also highlight such rare anomalies and their clinical implications in classroom teaching.

REFERENCES

1. Michels NA. Blood supply and anatomy of the upper abdominal organs with descriptive atlas. Philadelphia: Lippincott Co, 1955.
2. Hiatt JR, Gabbay J, Busutil RW. Surgical anatomy of the hepatic arteries in 1000 cases. *Ann Surg* 1994; 220:50-2.
3. Convey AM, Brody LA, Maluccio MA, Getrajdman GI, Brown KT. Variant hepatic arterial anatomy revisited: digital subtraction angiography performed in 600 patients. *Radiology* 2002; 224:542-7.

4. López-Andújar R, Moya A, Montalvá E, et al. Lessons learned from anatomic variants of the hepatic artery in 1,081 transplanted livers. *Liver Transpl* 2007; 13:1401-4.
5. Brittain RS, Marchioro TL, Hermann G, Waddell WR, Startzl TE. Accidental hepatic artery ligation in humans. *Am J Surg* 1964; 107:822-32.
6. Standring S. *Gray's anatomy: the anatomical basis of clinical practice*, 39th ed. Edinburgh: Elsevier Churchill Livingstone, 2005.
7. Romanes GJ. *Cunningham's textbook of anatomy*. Oxford: Oxford University Press, 1981.
8. Snell RS. *Clinical anatomy*. 7th ed. Philadelphia: Lippincott Williams and Wilkins, 2003.
9. Mays ET 2nd, Mays ET. Are hepatic arteries end-arteries? *J Anat* 1983; 137:637-44.
10. Soliman T, Bodingbauer M, Langer F, et al. The role of complex hepatic artery reconstruction in orthotopic liver transplantation. *Liver Transpl* 2003; 9:970-5.