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Quadruple Arterial Blood Supply to the Liver: A Rare Variation

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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Case Report

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ABSTRACT

Introduction: Vascular variations in the liver are significant to surgeons in liver transplantations, radiological procedures, laparoscopy and penetrating abdominal injuries. These variations are important in liver transplantation procedure, in addition to being an ideal opportunity for surgical anatomy study, their detailed identification is crucial to the success of the procedure.
Case Report: During a routine cadaveric dissection of the abdomen for medical students at the department of Anatomy Usmanu Danfodiyo University, Sokoto Nigeria. A male adult cadaver with unknown identity and cause of death, was found to have four arterial branches to the liver, one each from the left gastric artery and common hepatic artery, a branch from the gastro-duodenal artery and the hepatic artery.
Conclusion: Detailed knowledge of the variations of hepatic arterial anatomy is of utmost importance to surgeons who perform surgeries in this area, particularly in liver transplantation, since their identification and proper management are critical to the success of the procedure.

Keywords: Quadriple; arterial; blood supply; liver; variation.

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1. INTRODUCTION

Liver and other abdominal organs blood supply play a very important role during abdominal surgeries. Information about the common patterns of vascular supply should be increased and new anomalies of the celiac trunk and other arteries around it are poorly reported. Vascular variations in the liver are significant to surgeons, in radiological procedures, liver transplantations, laparoscopy and penetrating injuries to the abdomen around the liver [1-3]. "These variations are important in liver transplantation procedure, in addition to being an ideal opportunity for surgical anatomy study, their detailed identification is vital to the success of a surgical procedure" [4,5].

"The classical arterial supply to the liver is only found in 50-80% of cases. Several classifications attempt to define and sort these variations, the most commonly used being Hiatt/Michels'" [6]. "Early identification of arterial variations can prevent vascular damage during harvesting and back table surgery that could lead to postoperative complications. There are few published series focusing on donor hepatic arterial variations. This information is crucial when conducting hepatic or pancreatic surgery as injuring to an aberrant hepatic artery can deeply affect the postoperative outcome of the patient" [7].

"In 55%-75% of the individuals, the normal hepatic arterial supply consists common hepatic artery arising from the celiac trunk, which becomes hepatic artery proper after the origin of the gastroduodenal artery, the hepatic artery proper give rise to a right hepatic artery (RHA) and a left hepatic artery (LHA), which supply the right and left lobes of the liver respectively" [8]. "The presence of hepatic artery variations should always be preoperatively assessed as this information can condition the possibility to perform a radical liver tumor resection with negative margins and/or be responsible for life-threatening postoperative complications. Vascular anatomy is generally evaluated through contrast-enhanced computed tomography which guarantees elevated sensitivity and specificity" [9,10].

In this case report, we present to you from the Department of Anatomy, Faculty of Basic Medical Sciences of the Usmanu Danfodiyo University, Sokoto, Nigeria. A male adult cadaver, with four arterial branches to the liver. The aim of this report is to increase awareness of this anatomical variation, and to demonstrate the presence of this form of variation among our population.

2. CASE REPORT

During a routine dissection of the abdomen for medical students at the department of Anatomy Usmanu Danfodiyo University, Sokoto. A male adult cadaver with unknown identity and cause of death, was found to have an unusual multiple arterial supply to the liver. The left gastric artery gave a branch to the liver (the 1st branch to the liver in Fig. 1). A separate branch to the liver was given off by the common hepatic artery (the 2nd branch to the liver in Fig. 1). The hepatic artery enters the liver as a single artery, without dividing into a right and left hepatic arteries (the 3rd branch to the liver in Fig. 1). The gastro-duodenal artery after branching off from the common hepatic artery, also gave a branch to the liver (the 4th branch to the liver in Fig. 1).

Essentially there were four arterial branches to the liver. The left lobe of the liver was essentially supplied by 1st and 2nd branches from left gastric and common hepatic arteries respectively. The right lobe of the liver was essentially supplied by 3rd branch, which is the hepatic artery proper and 4th branches from gastroduodenal artery. No other arterial anomaly was observed in the region.

3. DISCUSSION

Anatomically, the celiac trunk is the first artery to originate anteriorly from the abdominal aorta at the level of T12. It splits into 3 branches: the left gastric artery, the splenic artery, and the common hepatic artery. "The celiac trunk is the artery of the foregut, it supplies blood to the liver, gallbladder, spleen, pancreas, and gut from the distal esophagus to the ampullar of vater" [6,8].

"Embryologically, the celiac trunk develops from six pairs of ventral splanchnic vessels (subphrenic, upper, middle, lower ventricular and upper and lower intestinal). During intrauterine development, these branches disappear following vascular extensions and branching. However, the persistence of longitudinal channels between primitive vessels may lead to vascular anomalies or variations in this region" [11]. Variations in blood supply to the liver has been described by many authors [1, 12-14]. "However, we are yet to find report on the quadrupled arterial supply from the branches of

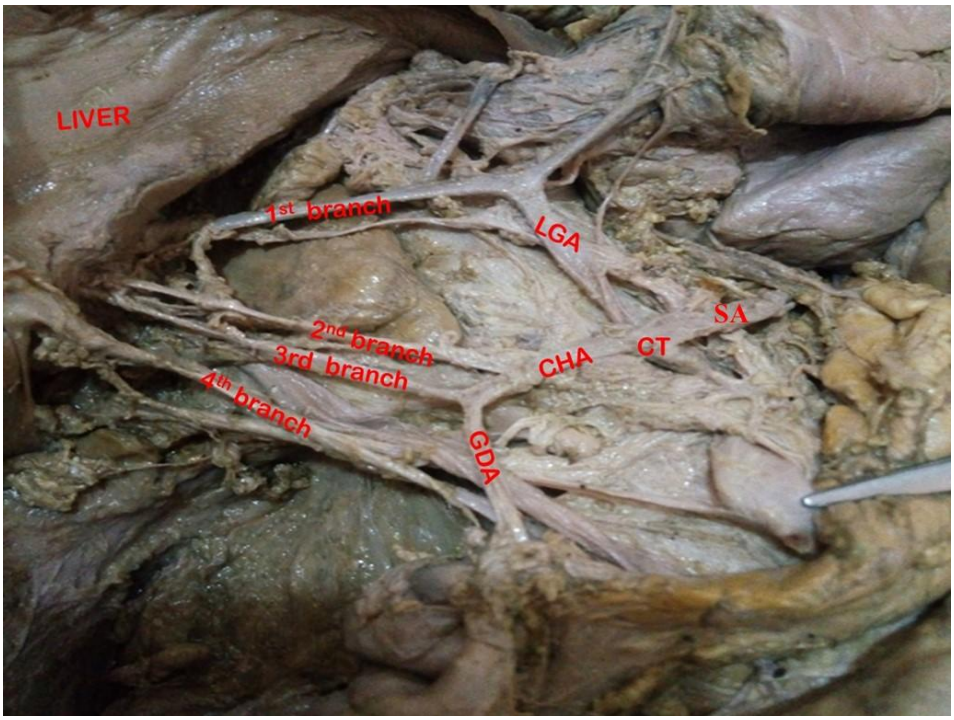

Fig. 1. Image of the dissected abdomen showing four different arteries to the liver and other arteries from the celiac trunk (CT)

LGA: Left Gastric Artery, SA: Splenic Artery, CHA: Common Hepatic Artery, GDA: Gastroduodenal Artery, 1st branch from left gastric artery, 2nd branch from Common hepatic artery, 3rd branch is the hepatic artery proper, 4th branch from gastroduodenal artery

coeliac artery except the splenic artery. Galen was the first anatomist who researched the arterial system from the celiac trunk and observed the arteries leading to the liver, stomach and spleen" [6]. "Later on, Andreas Vesalius gave anatomical descriptions of the Galen's discoveries in the sixteenth century" [6]. "On the basis of Hiatt's classification, the most common hepatic artery variation was accessory or replaced left hepatic artery, this is not the case in the cadaver dissected by our group" [2].

"The presence of an accessory right hepatic artery (aRHA) or a replaced right hepatic artery (rRHA) does not seem to impact on postoperative outcomes, and should not be considered as a contraindication to minimal invasive surgery approach when planning for pancreaticoduodenectomy (PD)" [13,14]. However, as found in this study, the surgeon should have in mind the possibility of a conversion to laparotomy because of a branch to the liver that is coming from the pancreaticoduodenal artery, which may expose the patient to the risk of vascular injuries. "Variant arterial anatomy is common, occurring in nearly half of the population" [15]. "However, 4 arteries from different origin supplying the liver have not been reported. In cases where a liver transplant is planned, or when a surgical management of patients with pancreatic and hepato-biliary neoplasms is arranged, recognition of these vascular anomalies may significantly affect the surgical approach" [15].

"The anatomical variations in the coeliac trunk and hepatic arterial system were evaluated by Gurgacz et al with multidetector CT (MDCT) angiography among 100 patients in Poland. Normal anatomy was reported in 50% of the patients. The remaining 50% were reported to have either coeliac trunk or hepatic artery variation" [7]. "None of the patients in this 50% have the type of variation found in our report. Liver segment IV is of critical importance in liver transplant surgery because its vascular and biliary anatomy are of immense significance in liver regeneration following resections. For that reason, it is important to know the origin of its blood supply. In an MDCT study conducted by Kamel et al, the segment IV artery was reported to originate from the right hepatic artery in 62.5% of cases" [16]. In our study, the arterial supply to segment, will most likely originate from the 4th

branch to the liver which is coming from the gastroduodenal artery.

"A normal hepatic arterial system has been reported in 51–80% of cases in most studies conducted using Digital subtraction angiography DSA" [17,18]. "In the literature, the most frequently encountered variation is Type III, which is replaced RHA from superior Mesenteric artery, present in between 6% and 15.5% of all cases" [19,20]. "The second most frequent variation, Type II, was reported in 2.5–10% of all cases" [21-23]. "The findings of our study are not reported in any of these studies. This report highlights the significance and relevance of the traditional cadaver dissection to the training of medical and allied students, in spite of its challenges and drawbacks" [24]. "In spite of the growing advocacy for virtual dissection in anatomy education, cadaver dissection remains the gold standard for anatomical studies, as stated by the International Federation of Associations of Anatomists (IFAA)" [25]. "This is because, students acquire the skills and relate to structural relationships, and also see anatomic variations of significant surgical and medical relevance, that widens the coverage of medical knowledge, and improves their confidence, competence, mastery, interpersonal communication skills, mental and emotional development" [26-28].

4. CONCLUSIONS

These arterial patterns are critical to the planning and precise preoperative evaluation for all surgical and radiological procedures in the upper abdomen. This information goes beyond simple academic knowledge, they profoundly influence practice and success of the procedures depends on them. Surgeons should be aware of all potential variations around the liver to avoid complications postoperatively.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Varotti G, Gondolesi GE, Goldman J, Wayne M, Florman SS, Schwartz ME, et al. Anatomic variations in right liver living donors. J Am Coll Surg. 2004;198:577–582.
2. Hiatt JR, Gabbay J, Busuttil RW. Surgical anatomy of the hepatic arteries in 1000 cases. Ann Surg. 1994; 220:50–52.
3. Gruttadauria S, Foglieni CS, Doria C, Luca A, Lauro A, Marino IR. The hepatic artery in liver transplantation and surgery: vascular anomalies in 701 cases. Clin Transplant. 2001;15:359–363.
4. Suzuki T, Nakayasu A, Kawabe K, Takeda H, Honjo I. Surgical significance of anatomic variations of the hepatic artery. Am J Surg. 1971;122:505–512.
5. Covey AM, Brody LA, Maluccio MA, Getrajdman GI, Brown KT. Variant hepatic arterial anatomy revisited: digital subtraction angiography performed in 600 patients. Radiology. 2002;224:542–547.
6. Michels NA. Newer anatomy of the liver and its variant blood supply and collateral circulation. Am J Surg. 1966;112(3):337-47.
7. Gurgacz AM, Horbaczewska A, Klimek-Piotrowska W, Walocha J. Variations in hepatic vascularisation: lack of a proper hepatic artery. Two case reports. Folia Morphol (Warsz). 2011;70(2):130-4.
8. Moore KL, Authur FD. Clinically oriented Anatomy (5th ed). Ontario, Canada: Lippincitt Williams & Wilkins. 2006:609—16.
9. Kosaka M, Horiuchi K, Nishida K, Taguchi T, Murakami T, Ohtsuka A. Hepatopancreatic arterial ring: bilateral symmetric typology in human celiaco-mesenteric arterial system. Acta Med Okayama. 2002;56(5):245-53.
10. Moore KL, Persaud TV, Torchia MG. The developing human. E-book: clinically oriented embryology. Elsevier Health Sci. 2018:363—8.
11. Prakash, Rajini T, Mokhasi V, Geethanjali BS, Sivacharan PV, Shashirekha M. Coeliac trunk and its branches: anatomical variations and clinical implications.

Singapore Med J. 2012;53(5):329–331.
12. chwarz L, Huet E, Yzet T, Fuks D, Regimbeau JM, Scotte M. An extremely uncommon variant of left hepatic artery arising from the superior mesenteric artery. Surg Radiol Anat. 2014;36(1):91–94.
13. Lopez-Andujar R, Moya A, Montalva E, Berenguer M, De Juan M, San Juan F, Pareja E. et al. Lessons learned from anatomic variants of the hepatic artery in 1,081 transplanted livers. Liver Transpl. 2007;13(10):1401–1404.
14. Chierici A, Castaldi A, El Zibawi M, Edoardo R, Antonio I. How to deal with right hepatic artery coming from the superior mesenteric artery during minimally invasive pancreaticoduodenectomy: A systematic review. Hepatobiliary & Pancreatic Diseases International. Available:https://doi.org/10.1016/j.hbpd.2022.12.005
15. Chen CY, Lee RC, Tseng HS, Chiang JH, Hwang JI, Teng MM. Normal and variant anatomy of the hepatic arteries: angiographic experience. Chin Med J. 1998;61:17–23.
16. Kamel IR, Kruskal JB, Pomfret EA, Keogan MT, Warmbrand G, Raptopoulos V. Impact of multidetector CT on donor selection and surgical planning before living adult right lobe liver transplantation. AJR Am J Roentgenol. 2001;176:193–200.
17. Fasel JHD, Muster M, Gailloud P, Mentha G, Terrier F. Duplicated hepatic artery: radiologic and surgical implications. *Acta Anat.* 1996;157:164–8.
18. Weiglein AH. Variations and topography of the arteries in the lesser omentum in humans. *Clin Anat.* 1996;9:143–50.
19. Daly JM, Kemeny N, Oderman P, Botet J. Long-term hepatic arterial infusion chemotherapy. Arch Surg. 1984;119:936–41.
20. De Santis M, Ariosi P, Calo GF, Romagnoli R. Anatomia vascolare arteriosa epatica e sue varianti. *Radiol Med* 2000;100:145–51.
21. Koops A, Wojciechowski B, Broering DC, Adam G, Krupski-Berdien G. Anatomic variations of the hepatic arteries in 604 selective coeliac and superior mesenteric angiographies. Surg Radiol Anat. 2004;26:239–44.
22. Erbay N, Raptopoulos V, Pomfret EA, Kamel IR, Kruskal JB. Living donor liver transplantation in adults: vascular variants important in surgical planning for donors and recipients. AJR Am J Roentgenol. 2003;181:109–14.
23. Abdullah SS, Mabrut JY, Garbit V, De LaRoche E, Olagne E, Rode A, et al. Anatomical variations of the hepatic artery: study of 932 cases in liver transplantation. Surg Radiol Anat. 2006;28:468–73.
24. Chia TI, Oyeniran OI, Ajagbe AO, Onigbinde OA, Oraebosi MI. The symptoms and stress experienced by medical students in anatomy dissection halls. J Taibah Univ Med Sci. 2020;15:8.
25. International Federation of Associations of Anatomists (IFAA). Best practice guidelines for body donation programmes during the novel Coronavirus pandemic; 2020. Available:http://www.ifaa.net/wp-content/uploads/2020/05/IFAA. Staement-on-COVID-19 -final-v2.pdf [Assessed 15th January 2023].
26. Iwanaga J, Loukas M, Dumont AS, Tubbs RS. A review of anatomy education during and after the COVID-19 pandemic: Revisiting traditional and modern methods to achieve future innovation. Clinical Anatomy. 2021;34:108—14.
27. Onigbinde O, Ajagbe A, Oyeniran OI, Chia T. Post-COVID-19 pandemic: standard operating procedures for gross anatomy laboratory in the new normal. Morphologie. 2021;105(350):196-203.
28. Onigbinde OA, Chia T, Oyeniran OI, Ajagbe AO. The place of cadaveric dissection in post COVID-19 anatomy education. Morphologie. 2021;105(351):259-266.

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