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A Study on Variations of Branching Pattern of Hepatic Arteries with its Clinical Significance

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ABSTRACT

Background

Variation of hepatic artery is very frequent and may predispose the patients to inadvertent injury to the vessels during hepato-billiary surgery. With the advancement of new diagnostic, therapeutic and operative techniques for abdomen, the sound knowledge of variations of hepatic arterial system have become increasingly important for dealing clinicians, surgeons and interventional radiologists.

Objective

To study the variations of hepatic artery and to evaluate the possible clinical significances.

Method

A total of 104 images of abdominal computed tomography scans were used for this study. The origin and branching patterns of hepatic artery were recorded. After collecting the data, statistical analysis was done.

Result

The present study concluded that normal branching pattern of hepatic artery was seen in 86.54% cases, whereas 13.46% cases showed different types of variations. Among them, type II and IV pattern were seen in 0.96% in each, type VI in 1.93%, type VII in 2.87% and the most common variation type IX was seen in 3.85%. There were not a single case of type III, V, VIII and X recorded in this study. Addition to these, one of the variants was common hepatic artery originating from abdominal aorta, was seen in 1.93% of cases while the other variant is unnamed artery arising from superior mesenteric artery, was seen in 0.96% of cases.

Conclusion

The knowledge of the branching pattern of hepatic artery might be helpful for clinicians to the better understanding of the arterial supply of the liver and may reduce the risk of complications.

KEY WORDS

Hepatic artery, Hepatic artery proper, Left hepatic artery, Right hepatic artery

INTRODUCTION

Liver receives the arterial supply from the hepatic artery proper (HAP) derived from the common hepatic artery (CHA). The CHA gives off the gastroduodenal artery and then continues as HAP. The right gastric artery (RGA) arises as a branch from the HAP. Subsequently, the HAP dividing into the right and left hepatic arteries (HA) that supplies the liver.[1]

The normal hepatic arterial system was found to be only in 50-80% of cases and the remaining showed variations.[2,3] An intact HA is the gateway to successful hepatobiliary surgery. Division or damage with subsequent thrombosis produces ischemia of liver which can have devastating consequences on the patient.[4] Therefore, the incidence of hepatic vascular variants reinforce the need for accurate preoperative vascular imaging and to avoid inadvertent injury to the vessels intraoperatively.[5,6] Vascular variations can also become a technical problem for infusion therapy and transarterial chemoembolization of neoplasm in the liver.[7,8]

Since, it is known that HA vary in relation to its origin and branching pattern, this study was aimed to study the variations in branching pattern of HA among Nepalese population. This study may contribute to the better understanding of the arterial supply of the liver and may reduce the risk of complications of surgical procedures and radiological interventions.

METHODS

This was the cross-sectional and retrospective study that consisted of images of abdominal computed tomography (CT) angiography scans of 104 individuals (50 males and 54 females). The images were collected from the Department of Radio-diagnosis, Dhulikhel Hospital during the period of March 2017–August 2018 and the study was conducted in the Department of Anatomy, Kathmandu University School of Medical Sciences, Dhulikhel, Kavre, Nepal. The images with an arterial phase covering the abdominal aorta were included for the study. The images with incomplete demographic data or without adequate arterial phases were excluded. Prior to the study, approval for the study was taken from IRC-KUSMS. The HA was analyzed for its origin and branches. Presence or absence of any accessory branch was recorded by using angiographic images of Multi Detector Computed Tomography (MDCT). The variations of HA were classified on the basis of Michel's classification as shown in Table 1.[9]

RESULTS

The study concluded that 90 (86.54%) of cases had presented normal pattern of HA (Type I) as shown in figure 1 that is RHA and LHA arising from HAP, whereas 14 (13.46%) of the cases showed different types of variations as mentioned in Table 2.

Table 1. Hepatic Artery Variations: The Michel's Classification

Type I	GDA and HAP from CHA; RHA and LHA from HAP
Type II	rLHA from LGA
Type III	rRHA from SMA
Type IV	rLHA from LGA & rRHA from SMA
Type V	aLHA from LGA
Type VI	aRHA from SMA
Type VII	aLHA from LGA and aRHA from SMA
Type VIII	aLHA from LGA and rRHA from SMA
Type IX	CHA originating from SMA
Type X	Entire Hepatic trunk from LGA

GDA: Gastro-duodenal Artery, HAP: Hepatic Artery Proper, CHA: Common Hepatic Artery, RHA: Right Hepatic Artery, LHA: Left Hepatic Artery; rLHA: Replaced Left Hepatic Artery, LGA: Left Gastric Artery; rRHA: Replaced Right Hepatic Artery, SMA: Superior Mesentric Artery, aLHA: Accessory Left Hepatic Artery and aRHA: Accessory Right Hepatic Artery

Table 2. Showing different types of variations

Type		Frequency	Percentage
I		90	86.54
II		1	0.96
III		0	0
IV		1	0.96
V		0	0
VI		2	1.93
VII		3	2.87
VIII		0	0
IX		4	3.85
X		0	0
Others	CHA from AA	2	1.93
	One artery from SMA	1	0.96
Total		104	100

AA: Abdominal Artery

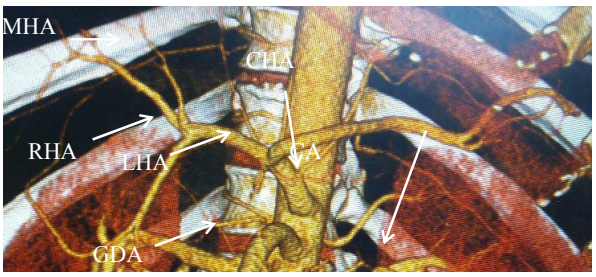

Figure 1. Showing Type I pattern

Type II: This type of variations with presence of rLHA originating from LGA, was seen in 0.96% (N = 1) cases as illustrated in figure 2.

Type IV: Presence of rRHA and rLHA where RHA originated from SMA and LHA from LGA were observed in 1 (0.96%) as illustrated in figure 3.

Type VI: Presence of aRHA arising from SMA was seen in 2(1.93%) as shown in figure 4.

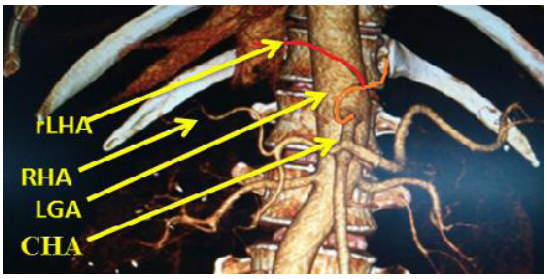

Figure 2. Showing Type II pattern

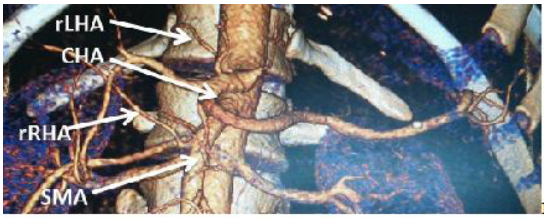

Figure 3. Showing Type IV pattern

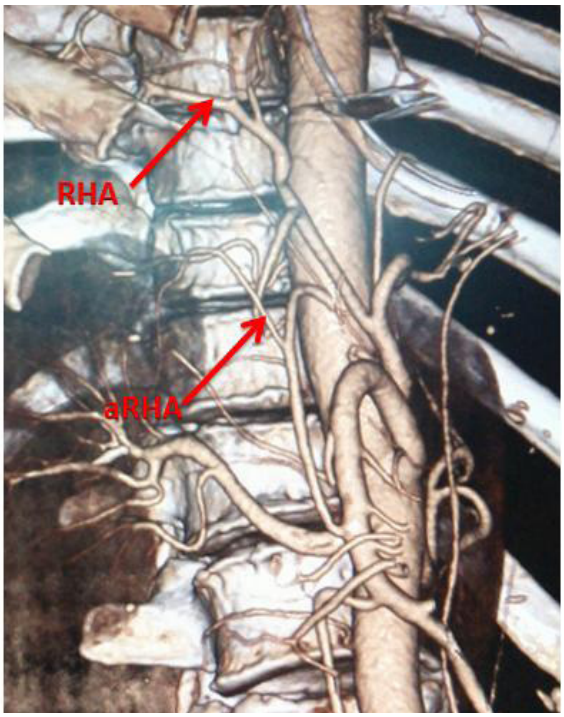

Figure 4. Showing Type VI pattern

Type VII: It was observed aLHA originating from LGA and aRHA starting from SMA. This variant was seen in 3 (2.87%) cases which was the second commonest incidence as shown in figure 5.

Type IX: It was observed that CHA originating from SMA was seen in 5 (3.85%) cases. This variant was the most common type found in the present study as shown in figure 6.

In the present study, Type III, Type V, Type VIII and Type X of variations were not noticed among the studied samples.

It was also possible to find other anatomical variant that were not included in Michel's . There were two different types of variants which were recorded in this study as

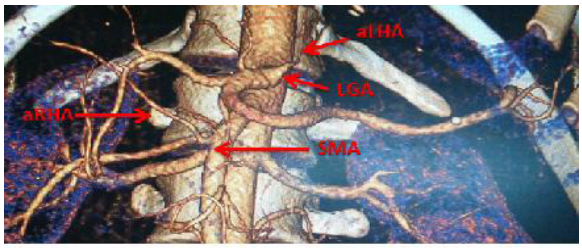

Figure 5. Showing Type VII pattern

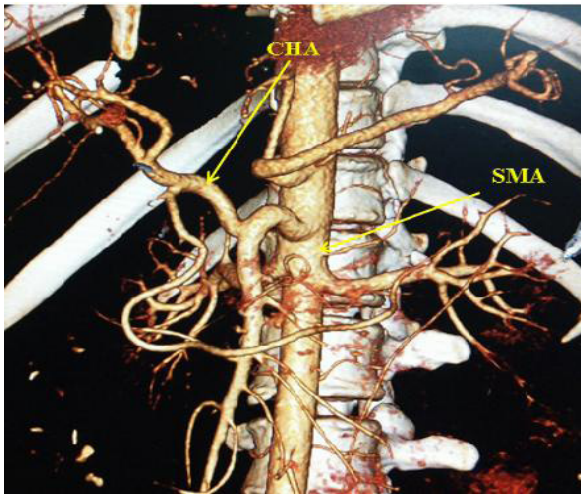

Figure 6. Showing Type IX pattern

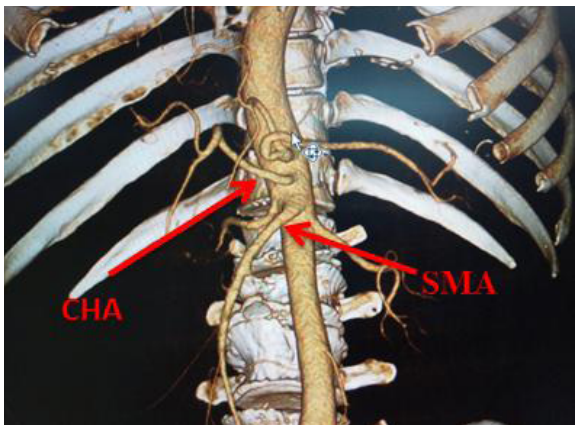

Figure 7. Showing unclassified variation

Figure 8. Showing unclassified variation

entire hepatic trunk that originating directly from AA. The incidence of this pattern was observed in 2 (1.93%) cases as shown in figure 7.

A very uncommon branching pattern was also observed in 1 (0.96%) case of the studied samples, where one artery arising from SMA and gives two branches as illustrated in figure 8.

DISCUSSION

The variations in the hepatic arterial system are extremely common which were found in the present study. Similarly, the hepatic and its branches showed several variations and has been well documented in the literatures.[10,11] The frequency of normal vascular pattern where GDA and HAP from CHA; RHA and LHA from HAP was observed in 86.54% of cases while 13.46% of the cases had some form of vascular variant in the present study. Similar to this, most of the authors showed higher frequency of normal type I pattern than other variations.[12,13] However Nemeth stated the occurrence of type I pattern only in 42% of cases while variant pattern was in the majority of cases (58%).[14]

Type II pattern where rLHA originating from LGA was observed in 7.14% of cases in the present study. The authors also claimed similar arrangement in 5%, 6% and 10.8% respectively.[12-14] Whereas some authors declared absence of this variant in their study.[10,11] In this type of variation there is high chance of ischemia to left lobe of liver if this variation is not recognized during a radical gastrectomy.[15]

Similar to few authors there was not a single case of type III pattern in this study.[16-18] In contrast, many studies revealed type III variation and they recorded this configuration in15.16% and 16% respectively.[11,12] A study quoted the occurrence of this variant in majority (25%) of the studied cases.

The frequency of occurrence of type IV that refers to rLHA from LGA and rRHA from SMA pattern was seen in 7.14% in the present study. According to Kamath, this type IV configuration was present in 15% whereas Nemeth have reported type IV pattern to be present only in 4% in their study.[13,14] In contrast, majority of the authors mentioned the occurrence of type IV variation in their studies.[10,20] The knowledge of this variation in inevitable to decrease operative and postoperative morbidity and mortality of hepatic and peri-hepatic surgeries.[21]

Type V pattern in which aLHA from LGA was also absent in this study. Similarly, many authors have also revealed absence of type V configuration.[10,11,19] However, the studies depicted this alignment in 8% and 10% respectively.[14,13] Analogous to Seghal et al. occurrence of type VI where aRHA from SMA configuration was found to be present in 14.29% in the present study.[11] Comparatively Surekha et al. declared the presence of such variant in their study but in low frequency (5.16%).[12] While several other authors depicted absence of this pattern.[14,22]

Type VII in which aLHA from LGA and aRHA from SMA was second common variation in current study and was observed in 21.43%, while Surekha et al. reported its occurrence in 12.76% and Nemeth in 2%.[12,14] Conversely, majority of authors declared nonexistence of type VII variant.[13,19] As branching of arteries are conquered in embryonic life, none of the cases showed presence of type VIII pattern in this study and so majority of authors.[12,13,20,22] In contrast Nemeth reported the occurrence of type VIII configuration in 4%.[14] With increase in number of liver transplantation, the understanding on anomalous hepatic artery anatomy become crucial and pre-operative imaging is mandatory.

The most common type of variation in the present study was type IX which refers to CHA originating from SMA, observed in 71.43%. Comparatively, Zagyapan et al. and Nemeth reported presence of type IX variant but in low frequency, in 2% and 6.6% respectively.[10,14] While other authors declared absence of type IX variant in their study.[11,13] The occurrence of type X where entire Hepatic trunk from LGA variant was not seen in majority of the studies and so in current study too.[11-12] However, some authors revealed existence of this does in type.[14,20]

Result of current study show substantial differences concerning the variations of the hepatic arteries, compared to the literary data of other authors. Usually differences arise during several developmental stages in the embryonic process which lead to a range of variations in these vascular structures. Retention or disappearance of parts of this primitive arterial plexus could give rise to numerous anatomical variations in the hepatic artery.[23]

This study demonstrated two different unnamed extra hepatic arterial variants. These unclassified variants were observed CHA originating from AA and uncommon artery arising from SMA supplying liver. One of the variant, CHA originating from AA, though this configuration is unclassified; frequency of occurrence of this pattern is usually common among the literature. Most authors have reported this pattern.[24,25] There is increased chance of iatrogenic hepatic vascular injury during surgical procedures in such aberrant variation.

However, the other variant, uncommon artery originating from SMA is only reported in this study. To the best of our knowledge, this study is the first to demonstrate this variant which was to be recognized accurately before surgery in order to avoid graft injury and ensure a safe hepatectomy.[14]

CONCLUSION

It is evident from this study that variations in the arterial supply of liver are very common. A higher prevalence of type IX variant was found in the present study. Besides ten different types of hepatic arterial variations, the present study demonstrated two new unclassified hepatic arterial configurations. It is an accepted fact that variations of the hepatic artery do frequently exist and thus its existence may not be undermined. Variations of HA are of utmost clinical importance because the presence of such variations can affect surgical, oncologic or interventional procedures. The complications in abdominal surgeries could be avoided with the accurate knowledge of these variations.

REFERENCES

1. Standring S, Gray H. Gray's anatomy: The anatomical basis of clinical practice. 40th ed. Churchill Livingstone Elsevier: Edinburgh 2008:1163-75.
2. Anson BJ, Lyman TY, Lander HH. The abdominal viscera in situ; A study of 124 consecutive cadavers. *Anat Rec*. 1951; 76:28.
3. Eisendrath DN. Anomalies of the bile ducts and blood vessels, as the causes of accidents in biliary surgery. *JAMA.* 1918; 71(11):864-7.
4. Jones RM, Hardy KJ. The hepatic artery: A reminder of surgical anatomy. *J R Coll Surg Edinb*. 2001; 46:168-70.
5. Chiang KS, Chang P, Lee S, Yen P, Ling C, Lee W, et al. Angiographic evaluation of hepatic artery variations in 405 cases. *Chin J Radiol-TAIPEI*- 2005; 30(2):75-81.
6. Mehta V, Dave V, Suri RK, Rath G. Quadrifurcation of the hepatic artery proper in conjunction with double right gastric arteries. *Singapore Med J.* 2012; 53(10):211-13.
7. Chen CY, Lee RC, Tseng HS, Chiang JH, Hwang JI, Teng MM. Normal and variant anatomy of hepatic arteries: Angiographic experience. *Chin Med J*. 1998; 61:17-23.
8. Daly JM, Kemeny N, Oderman P, Botet J. Long-term hepatic arterial infusion chemotherapy. Anatomic considerations, operative technique, and treatment morbidity. *Arch Surg*. 1984; 119:936-941.
9. Michels NA. Newer anatomy of the liver and its variant blood supply and collateral circulation. *Am J Surg.* 1966; 112:337-47.
10. Zagyapan R, Kurkcuoglu A, Bayraktar A, Pelin C, Aytekin C. Anatomic variations of the celiac trunk and hepatic arterial system with digital subtraction angiography. *Turk J Gastroenterol.* 2015; 25(1):104-9.
11. Sehgal G, Srivastava A, Sharma P, Kumar N, Singh R, Parihar A et al. Morphometry of the celiac trunk: A multidetector computed tomographic angiographic study. *J Anat Soc India*. 2013; 62(1):23-7.
12. Surekha B, Mittal M, Mittal A, Sinha M, Bhambri N, Thukral B. Variations of celiac axis, common hepatic artery and its branches in 600 patients. *Indian J Radiol Imaging*. 2013; 23(3):223-33.
13. Kamath BK. A study of variant hepatic arterial anatomy and its relevance in current surgical practice. *Int J Anat Res.* 2015; 3(1):947-53.
14. Nemeth K. Surgical anatomy of the extra and intrahepatic arteries of the human liver on corrosion casts. *Semmelweis Univ.* 2016:45-57.
15. Sebben GA, Rocha SL, Sebben MA, Parussolo FPR, Gonçalves BHH. Variations of hepatic artery: anatomical study on cadavers. *Rev Col Bras Cir*. 2013;40(3):221-6.
16. Chanasong R, Putiwat P, Roboon J, Sakulsak N. Accessory hepatic artery arising from celiac trunk: An incidence in a Thai cadaver. *Int J Morphol Internet.* 2014; 32(4):1136-9.
17. Foghi K, Ahmadpour S. Celiacomesenteric trunk: A case report. *Eur J Anat.* 2014; 18(3):191-3.
18. Patel J, Gosai P, Nirvan A, Shah R, Kanani S. A study of branching pattern of coeliac trunk in 100 Cadavers. *Int J Biol Med Res*. 2013; 4(3):3444-7.
19. Naveen K, Jyothsna P, Swamy R, Anitha G, Surekha D, Ashwini A et al. Trifurcated hepatic artery proper with unusual course and termination of right hepatic artery into fossa for gall bladder. *J Surg Acad.* 2014; 4(1):70-2.
20. Morawski M, Stankiewicz R, Ciszek B, Pacho R, Patkowski W, Krawczyk M. Uncommon branching pattern of the hepatic arteries in a living donor: a case report and brief literature review. *Folia Morphol*. 2016; 75(1):125-9.
21. Noussios G, Dimitriou I, Chatzis I, Katsourakis A. The main anatomic variations of the hepatic artery and their importance in surgical practice: review of the literature. *J Clin Med Res.* 2017;9(4):248-52.
22. Jelev L, Angelov AK. A rare type of hepatobiliary arterial system in man-presence of accessory left and replaced right hepatic arteries and double cystic arteries. *Anatomy*. 2015; 9(2):100-3.
23. Dandekar UK, Dandekar KN. Variant anatomy of the celiac trunk: Review of literature with a case report. *Int J Biomed Adv Res*. 2014; 5(10):480-4.
24. Ugurel M, Battal B, Bozlar U, Nural M, Tasar M, Ors F et al. Anatomical variations of hepatic arterial system, coeliac trunk and renal arteries: An analysis with Multidetector CT angiography. *Br J Radiol*. 2014:321-6.
25. De Cecco CN, Ferrari R, Rengo M, Paolantonio P, Vecchietti F, Laghi A. Anatomic variations of the hepatic arteries in 250 patients studied with 64-row CT angiography. *Eur Radiol.* 2009; 19(11):2765-70.