Jayeoba *et al.*, (2022)
Biological and Environmental Sciences Journal for the Tropics 20(2) August, 2023
ISSN 0794 – 9057; eISSN 2645 - 3142
BEST JOURNAL 20(2): 18 - 24
Date received: 09/03/2023
Date accepted: 12/05/2023
https://dx.doi.org/10.4314/bestj.v20i2.3

Classification of the Variant Hepatic Arterial Pattern Among Patients in Northern Nigeria (Case Study of Hausa Ethnic Group of Kano State)

Jayeoba, B.I[1], Moddibo,M.H[2] and A.O[3] Dare
[1] Directorate of Medical Services, Defence Headquarters, Abuja, Nigeria.
[2]Department of Anatomy, Faculty of Basic Medical Sciences, College of Health Sciences, Bayero University, Kano State, Nigeria.
[3]Department of Radiography and Radiation Sciences, University of Ilorin, Kwara State, Nigeria.
Corresponding author: bijayeoba@yahoo.com

ABSTRACT
The coeliac trunk is a wide ventral branch of abdominal aorta measuring about 1.25 cm in length and arising just below the aortic hiatus opposite the lower border of T12. The study investigated the classification of the variant hepatic arterial pattern among patients in northern Nigeria with particular focus on Hausa ethnic group of Kano State. The primary objective of the study was to classify hepatic arterial among adults in Kano state, Nigeria, by using three-dimension multidetector computerized tomography. The data utilized were obtained from the record unit of Radiology Department, Aminu Kano Teaching Hospital and ninety–three patients were used for the hepatic arterial classification. The result showed that the Michel's classification of type I known as Normal had the highest percentage of 58.1%, followed by the type II, 12.9% and the least was type VII with 2.2%. The Hiatt's classification, in this study also showed that the type I had the highest percentage of 58.1%, follow by the type II, (24.7%) and the least was type VI with 2.2% respectively. The determination of anatomical variations of the hepatic arteries among Hausa ethnic group of Kano state are of utmost importance for various surgical and radiological procedures to prevent any complications especially in liver transplantation.

Keywords: Hepatic arterial, Classification, Arterial variants, Coeliac trunk

INTRODUCTION
Coeliac trunk is a wide ventral branch of abdominal aorta measuring about 1.25 cm in length and arising just below the aortic hiatus opposite the lower border of T12. It passes almost horizontally forwards and slightly right above the pancreas and splenic vein, dividing into left gastric, splenic and common hepatic arteries (Osman and Abdrabou, 2016; Williams *et al*., 2020). The most common classical type of variation of coeliac trunk is known as trifurcation and was first observed by Haller as tripus Halleri. It was, and still is, considered to be the normal appearance of coeliac trunk. According to Haller, coeliac trunk divides into common hepatic, splenic and left gastric arteries, while the other divisions of coeliac trunk rarely occur in human populations (Haller, 1786).

The knowledge of hepatic arterial vascularization had a significant relevance for the daily practice of a wide range of practitioners including not only surgeons specialized in the hepato-biliary-pancreatic area, but also general surgeons and radiologists, mainly those who are dedicated to interventional radiologic treatments (Chen *et al*., 2019). Surgeons undertaking hepatobiliary surgery must know the coeliac trunk specifically the hepatic artery anatomy, and be able to recognize the multiple variants for safe surgery and low morbidity (Chen *et al*., 2019).

Past research of more than two decades on cadavers and living persons has shown a plethora of variations (Hiatt *et al*., 1994). It has equally been reported that about 15% of the population displays significant variations from the typical branching pattern (Hiatt *et al*., 1994). The anatomy of the hepatic artery, and its variants, has been described adequately in the literatures starting with Haller, (1786), Tidemann, (1822) (multiple anomalies), Adachi (1928) (28 subgroups), and classic analyses (Flint 1923;Osman and Abdrabou, 2016; Noussios *et al*., 2017 and Chen *et al*., 2019). A new emphasis was given to this anatomy by the introduction of liver transplantation (Chen *et al*., 2019). The arterial patterns are of importance in planning and performance of all surgical and radiological procedures in the upper abdomen. However, surgical mistakes from failing to appreciate hepatic artery anatomy continue to be made with serious consequences to the patient, and with medico-legal implications. It built on a previous report, and reemphasize the importance of identifying the morphology, anatomy, and variations of the celiac trunk and the hepatic artery. This anatomy has become even more important as computerized surgery develops.

Hence, the greater call for understanding of liver anatomy and survival of patients which depends largely on surgeons understanding of liver anatomy of individual patients. The Couinaud's classification which perhaps the most popular classification of liver anatomy divides the liver into 8 independent segments. The implication of this is that surgical resection of one segment can be performed independently without injuring the anatomy of adjacent segments especially the vascularization. It is the knowledge of this segmental system that determines the success of resection in surgical procedures (Noussios *et al*., 2017). Anatomical variations of the hepatic arteries are important in liver transplants, laparoscopic surgery, radiological abdominal interventions and penetrating abdominal injuries. For example, Munshi *et al*. (2020) reported that aberrant anatomy and variations in hepatic arterial supply often lead to inadvertent or iatrogenic hepatic vascular injury. This implies that sufficient diagnostic benchmark would be required if iatrogenic hepatic vascular injury would be prevented or minimized during intervention or invasive procedures. In United Kingdom (UK), Ugurel *et al*. (2020) also emphasized that the prevalence of variations in the coeliac trunk and hepatic arteries is increased in people with accessory renal arteries and when undertaking angiographic examinations directed towards a single organ, possible variations of vascular structure of other organs should be kept in mind. In India, Kamath (2018) concluded that a thorough knowledge of hepatic artery variance as well as their identification is important to increase rate of success in surgical and interventional procedures in hepatobiliary region. This is more important due to incidence of variations in branching pattern of hepatic artery. Many works has been done in the African Continent as well on variations in hepatic arterial pattern among Africans predominantly with the use of cadaver (Kamath, 2018). However, there are limited study in relevant extant literature on the classification of the variant hepatic arterial pattern among patients in northern Nigeria, particularly the populated Hausa ethnic group of Kano state. This is because, no standardize data is available as reference values for classification of the variant hepatic arterial pattern among patients in the study area.

METHODOLOGY

The study is a prospective, cross sectional study of 3D Multidetector computed tomography **(**MDCT) of patients who underwent abdominal CT scan (ACT) between December 2016 and July 2017 in Aminu Kano Teaching Hospital (AKTH).

The study was carried out in the Radiology Department of AKTH, located in Kano State, northwest region of Nigeria (Figure 1) on a latitude of 12^{o} 37/North, 9^{o} 33/South and 7^{o} 43/ West. Kano is bordered on the East by Bauchi and Jigawa States, to the South by Kaduna State and to the West and North by Katsina State. It has a total land mass area of 20,760sq-km. It is the only teaching hospital in the state and serves the most populous state in Northern Nigeria with a population of over 9,383, 682 (Census 2006). The state has almost equal distribution of Males 51% and females 49% (NPC, 2006). More so, the hospital serves as a referral hospital for both private and established hospitals.

Figure 1: Map of Nigeria showing Kano State (Source: Google map, 2013).

Abdominal contrasts enhanced MDCT images of male and female patients of age limits from 25 years and above were selected for study since liver is expected to achieve matured architecture from 25 years of age. All patients that underwent contrast enhanced abdominal MDCT investigation from February to July 2017 were considered for the study. A total of 93 patients were selected from CT Vitrea of AKTH. Sample size was taken based on previous studies (Kamath, 2018). Validation of data was ensured through the assistance of radiologists/radiographers in the department.

RESULTS AND DISCUSSION

Incidences of The Variant Hepatic Arterial Pattern Among Patients

Table 1 present the result obtained of the hepatic arterial variants according to Michel's classification and the incidence among the studied population. It was revealed that Michel's type I class (Normal Anatomy) accounted for 55% followed by Michel's type II (Left hepatic artery from left gastric artery) and III (Right hepatic artery from superior mesenteric artery) which account for 10% and 11% of the total incidence in of studied population respectively. Also, 8% and 7% of the incidence were found with Michel's type V (Accessory left hepatic artery from left gastric artery) and VI (Accessory right hepatic artery from superior mesenteric artery) hepatic arterial variants respectively. However, Michel's type X (Common hepatic artery from left gastric artery) shows the least incidence of hepatic arterial variants identified from the study population. Figure 2 shows a typical view of Michel's type I class (Normal Anatomy) of hepatic arterial variants.

Table 1: Hepatic Arterial Variants According to Michel's Classification and the Incidence

MICHEL'S TPYES	DESCRIPTION	INCIDENCE (%)
I	Normal Anatomy	55
II	Left hepatic artery from left gastric artery	10
III	Right hepatic artery from superior mesenteric artery	11
IV	Left hepatic artery from left gastric artery and right hepatic artery from superior mesenteric artery	1
V	Accessory left hepatic artery from left gastric artery	8
VI	Accessory right hepatic artery from superior mesenteric artery	7
VII	Accessory left hepatic artery from left gastric artery from accessory left hepatic from superior mesenteric artery	1
VIII	accessory left hepatic artery from left gastric artery and right hepatic artery from superior mesenteric artery	2
IX	Common hepatic artery from superior mesenteric artery	4.50
X	Common hepatic artery from left gastric artery	0.50

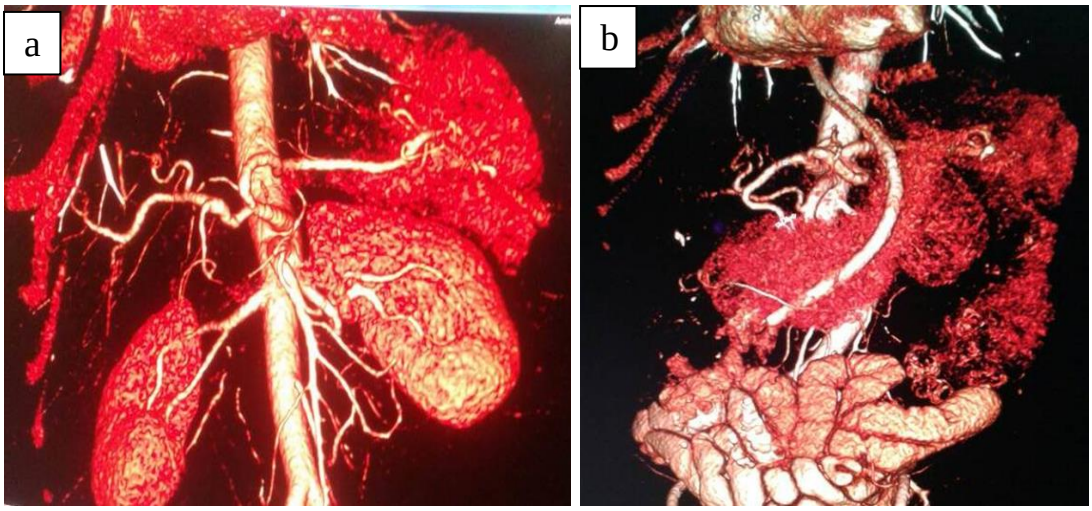

Figure 2: (a) Michel's and Hiatt's Type I of Hepatic Artery Variant; (b) Michel's Type III of Hepatic Artery Variant.

Distribution of Hepatic Arterial System of Michel's And Hiatt's Classification

The result in table 2 showed the frequency and the percentage classification of hepatic arterial system under the Michel's classification. The type I known as Normal had the highest percentage of 58.1%, followed by the type II 12.9% and the least was type VII with 2.2%. Type IV, VI, and VIII were not encountered in this study. The Chi-Square test did not show any significant difference in the frequency.

Table 2: Frequency Distribution of Hepatic of Michel's Classification of Hepatic Arterial Pattern and Chi-Square Test

Classification	Types	Males (%)	Females (%)	Total (%)
MICHEL	I	26(54.2)	28(62.2)	54(58.1)
	II	7(14.5)	5(11.1)	12(12.9)
	III	5(10.4)	6(13.3)	11(11.8)
	V	8(16.7)	3(6.7)	11(11.8)
	VII	2(4.2)	0(0.0)	2(2.2)
	Unclassified	0(0.0)	3(6.7)	3(3.2)
Total		48(100)	45(100)	93(100)

Pearson Chi – square 7.682 and significance 0.175

Table 3 shows the frequency and the percentage classification of hepatic arterial system under the Hiatt's classification. The type I known as Normal had the highest percentage of 58.1%, followed by the type II (24.7%) and the least was type VI with 2.2%. Type IV, V, VIII and IX were not encountered in this study. The Chi-Square test did not show any significant difference in the frequency.

Table 3: Frequency Distribution of Hepatic of Hiatt's Classification of Hepatic Arterial Pattern and Chi-Square Test

Classification	Types	Male (%)	Female (%)	Total (%)
HIATT	I	26(54.2)	28(62.2)	54(58.1)
	II	15(31.2)	8(17.8)	23(24.7)
	III	5(10.4)	6(13.3)	11(11.8)
	IV	2(4.2)	0(0.0)	2(2.2)
	VI	0(0.0)	3(6.7)	3(3.2)
Total		48(100)	45(100)	93(100)

Pearson Chi – square 7.206 and significance <0.125

DISCUSSION

The knowledge of the anatomical variants in hepatic vascular structures is of great importance in general surgery, especially in hepatic, pancreatic and laparoscopic surgeries. The knowledge is also of great importance in radiological procedures and treatment of penetrating injuries involving peri-hepatic area (Winston *et al.,* 2017). However, the incidence of occurrence of common and variant anatomical characteristics was not comprehensively described among Africans because most of the research reports were based on data obtained from the Western clime and lacked a comprehensive description of this important regional anatomy with relevance to a geographic regional variation especially in the context of West Africa. This is evidence from the finding from Table 1, which shows the variations in incidences of hepatic arterial in the studied area. In the present study, the type I Michel's classification of hepatic arterial system showed the highest percentage of 58.1% and it was within the rangesof the percentage classification (between 55% - 61%), although some previous studies are slightly higher in percentage values than the present study, most probably due to genetic and environmental factors.

In the present study, the second most frequent variation was type IIwith 12.9% followed by type III and V with 11.8% and 11.8% respectively with slight difference of one frequency between type II, andtypes III and V.Types VII and unclassified have been reported very rare in this study and types IV, VI, VIII, IX and X were not encountered in the study. The prevalence of these variations in this study series are slightly lower than those often reported, but are similar to those of Michel (2015), and the differences in percentage may probably be due to genetic and environmental factors. The type I of Hiatt's classification still have the same percentage with that of the Michel's classification of 58.1% followed by typeII with 24.7% which was different from type II of Michel's classification because of type V of Michel's classification would be considered as type II of Hiatt's classification, which increased the percentage of type II Hiatt. The least of percentage in this study were types IV and VI and others were not encountered. It was however reported in a similar study conducted by Fonseca-Neto *et al.* (2017) 5.63% of type II of both Hiatt and Michel's classification. The prevalence of these variations in this study series are slightly lower than those often reported. According to the literature, the prevalence of anatomical variations ranges from 20-50% (Zagyapan *et al.,* 2015). According to Michels classification, the most frequent change according to the literature is the type III present in from 6-15.5% of cases as reported by Ugurel *et al.* (2020). It stands out as the most important because it has the potential to affect surgical procedures being indispensable its identification (Sebben *et al.,* 2016). The findings obtained in this study is significantly greater than the 11% incidence seen in the Caucasian population studied by Michels (2015). It is also greater than the 12–15% incidence of Michels' type 3 patterns published in other studies (Covey *et al.,* 2012; Winston *et al.,* 2017). The present study showed that there was no relationship between age and variables while the other variables have mostly positive and rare negative correlations.

CONCLUSION

The classification of the variant hepatic arterial pattern of Kano state was studied. There was a high incidence of Michel's type I class (Normal Anatomy) which accounted for 55% of the total incidence followed by Michel's type II (Left hepatic artery from left gastric artery) and III (Right hepatic artery from superior mesenteric artery) which account for 10% and 11% of the total incidence of hepatic arterial variants in studied population respectively. Hepatic arterial classification of this study showed that the Michel's classification of type I known as Normal had the highest percentage of 58.1%, followed by the type II, 12.9% and the least was type VII with 2.2%. The Type I Michel'sand the Hiatt's classifications of hepatic arterial system in this present study had shown the highest frequencies and percentages which are in line with the world range of hepatic arterial classification.

REFERENCES

Adachi, B. (1928). Das Arteriensystem der Japaner, verlag der Kaiserlich-Japanischen Universitatzu Kyoto, 2(5): 364-370.

Chen, H., Yano. R., Emura, S. and Shoumura, S. (2019). Anatomic Variation of the Celiac Trunk with Special Reference to Hepatic Artery Patterns. *Annal journal of Anatomy,* 191 (4): 399–407.

Covey, A. M., Brody, L. A.., Maluccio, M. A., Getrajdman, G. I. and Brown, K.T. (2012). "Variant hepatic arterial anatomy revisited: digital subtraction angiography performed in 600 patients," *Radiology*, 224(2): 542–547.

Flint, E. R. (1923). Abnormalities of the Right Hepatic, Cystic and Gastroduodenal Arteries and of the Bile Ducts. *British Journal of Surgery,* 10: 509 – 519.

Fonseca-Neto, O.C.L., Lima, H.C.S., Rabelo, P., Melo, P.S.V., Amorim, A.G. and Lacerda, C.M. (2017). Anatomic Variations of Hepatic Artery: A Study In 479 Liver Transplantations. *ABCD Arq Bras Cir Dig*, 30(1):35-37

Haller, A.V. (1786). First Lines of Physiology, 1 (English Translation). Eddinburgh, P. 75

Hiatt, J. R., Gabbay, J. and Busutil, R. W. (2014). Surgical Anatomy of the Hepatic Arteries in 1000 Cases. *Annal Journal of Surgery,* 220: 50–52.

Kamath, K. (2018). A study of Variant Hepatic Arterial Anatomy and its Relevance in Current Surgical Practice. *International Journal of Anatomy*, 3(1): 947-953.

Michels, N. A. (2015). *Blood supply and anatomy of the upper abdominal organs, with a descriptive atlas*. Lippincott, Philadelphia, 139-143.

Munshi, I., Fusco, D., Tashjian, D., Kirkwood, J., Polga, J. and Wait, R.B. (2020). Occlusion of An Aberrant Right Hepatic Artery, Originating from the Superior Mesenteric Artery, Secondary to Blunt Trauma. *Journal of Trauma,* 48: 325–6.

Noussios, G., Dimitriou, I., Chatzis, I. and Katsourakis, A. (2017). The Main Anatomic Variations of the Hepatic Artery and Their Importance in Surgical Practice: Review of the Literature: A Review. *Journal of Clinical and Medical Research,* 9(4): 248 – 252.

Osman, A. M. and Abdrabou, A. (2016). Celiac Trucnk and Hepatic Artery Variant: A Retrospective Preliminary MSCT Report Among Egyptian Patients. *The Egyptian Journal of Radiaology and Nuclear Medicine*. 47: 1451 – 1458.

Sebben, G. A., Rocha, S. L., Sebben, M .A ., Parussolo Filho, P R . and Habu Gonçalves, B H. (2016). Variações da artéria hepática: estudo anatômico em cadáveres. *Rev. Col. Bras. Cir*, 40(3): 221-226.

Tiedemann, F. (1822). Tabularu Marteriarum Corporushumani. In: Koerpers, Carlsruhe, Miller C. F., edition., Abbildungen derPulsadern des menschlichen: 1–250

Ugurel, M. S., Battal, B. and Bozlar, U. (2020). Anatomical Variations of Hepatic Arterial System, Coeliac Trunk and Renal Arteries: An Analysis with Multidetector CT Angiography. *British Journal of Radiology*, 83: 661-7.

Williams, P. L., Bannister, L. H., Berry, M. M., Collins, P., Dyson, M. and Dussek, J. E. (2020). *Gray's anatomy.* 38th edition., Churchill Livingstone, 1548 – 1552.

Winston, C. B., Lee, N. A. and Jarnagin, W. R. *et al.* (2017). "CT angiography for delineation of celiac and superior mesenteric artery variants in patients undergoing hepatobiliary and pancreatic surgery," *American Journal of Roentgenology*,

Zagyapan, R., Kurkcuoglu, A., Bayraktar, A., Pelin, C. and Aytekin, C. (2015). Anatomic variations of the celiac trunk and hepatic arterial system with digital subtraction angiography. *Turkish J.Gastroenterol*, 25:104–9.