Journal of Morphological Sciences
J Morphol Sci
Brazilian Society of Anatomy

Case Report
J Morphol Sci 2024;41:77-85

Cadaveric and Post-Mortem Investigations for Rare and Combined Hepatic Artery Variants – Anatomical Implications in Surgical Practice

Thanuja Ande[1], Makani Thanuja Kumari[2], Kavya N[3], Subhadra Devi Velichety[4], Jyothi Ashok Kumar[5]

[1]Associate Professor, Department of Anatomy Apollo Institue of Medical Sciences & Research, Chittoor. Andhraparadesh, India
[2]Associate Professor, Department of Anatomy Government Medical College, Mahabubnagar, Telangana, India
[3]Assistant professor Government Medical College, Ongole, Andhraparadesh, India
[4]Professor & Head, Department of Anatomy, Apollo Institue of Medical Sciences & Research, Chittoor, Andhraparadesh, India
[5]Assistant Professor, Department of Anatomy, Apollo Institue of Medical Sciences & Research, Chittoor. Andhraparadesh, India

Disclose and conflicts of interest: none to be declared by all authors

ABSTRACT

Introduction: vascular variations are an unexpected finding while cadaveric dissections, postmortems, surgical, and diagnostic angiographic procedures. Those anomalies are commonly observed in the region of the abdomen. Usually, such abnormalities are asymptomatic but the existence of hepatic vasculature anomalies might cause accidental injuries to the vasculature while the surgical procedure. The present study was conducted on 50 specimens, 22 were done in the dissection hall cadavers, and 28 were collected from the post-mortem among the south Indian population irrespective of age and sex and investigated for variant hepatic arteries. The current study results demonstrated that the common hepatic artery (CHA) originated directly from the aorta in 2%, it was trifurcated into the right hepatic left hepatic (RHA), and gastroduodenal arteries (GDA) in 8%. It continued only as the left hepatic artery (LHA) in 16% and only as RHA in 4%. The RHA arose from CHA in 8%, from the superior mesenteric artery (SMA) in 10%, from GDA in 4%, and from replaced CHA in 2%. In one specimen, there were two replaced RHA, one arising from the SMA and another from the GDA. 26% of the specimens had aberrant RHA, of which 18% were replaced and 8% were accessories. The GDA accounted for 4% of the accessory RHA's origin, while the main hepatic artery (PHA) accounted for 2%. The LHA from the CHA in 8%, replaced the origin from the left gastric artery (LGA) in 4% and replaced CHA in 2%. The middle hepatic artery was noticed in 62% of the specimens. Surgeons and radiologists participating in angiographic procedures must have up-to-date knowledge of hepatic artery abnormalities.

Keywords: Hepatic artery; anomalies; Surgery, angiography; Liver.

Introduction

Both anatomists and radiologists have drawn attention to the many arteries supplying the hollow and solid viscera of the abdomen, particularly the liver, because of their importance in visceral surgery[1,2]. For many years, the anatomy of the hepatic arteries has been investigated, with pioneers like Aristotle and Galen contributing to the field. However, several anatomical anomalies were not identified until the seventeenth century, when Albert Haller and Jacques Benigne Winslow, who are regarded as the founders of modern angiology, accurately defined its blood irrigation[3–5].

These variations are particularly significant when it comes to orthotopic liver transplantation since, in addition to providing a good chance for surgical anatomical research, their accurate identification is essential to the successful completion of the procedure[3,6–8]. The occurrence of anatomical changes in the hepatic artery ranges from 20 to 50% in various series, based on the literature[4,9].

Some investigators, like Von Haller in 1756[10], Tiedemann in 1822[11], Flint in 1923[12], Adachi in 1928[13], and Michels in 1955[14], have documented the anatomy and variations of the hepatic artery. Tiedemann's research covered a variety of vascular abnormalities in the human body, whereas Haller's study was limited to the celiac trunk. Based on the origin of the arteries, Adachi and Michel, who both examined the hepatic artery, concluded several categories. In his groundbreaking study on the right hepatic, cystic, and GDA vascular abnormalities, Flint discussed how they relate to the bile duct. The prevalence of anatomical variations has been reported to range from 20% to 50% in the literature[4,9.] Several variations are known to appear at various phases of embryonic development.

Students and healthcare professionals must understand the hepatic artery system in depth and be familiar with it because of the high occurrence of variations in the system and how they affect procedures involving the area. The primary use of this information is in liver transplant surgery. When

DOI: 10.51929/jms.41.77.2024
ISSN 2177-0298

probable anatomical variances are identified, both in organ donation and in liver implantation, whether from a living donor or a cadaver, a considerable number of difficulties can be avoided. Studying and understanding the many anatomical variances, especially those relating to the liver, is crucial in this scenario. For successful diagnostic and surgical therapy, it is crucial to recognize them and handle them effectively. The purpose of this research was to dissect human cadavers and postmortem specimens to examine the variations of the hepatic artery system, and the prevalence of anatomical differences, and to compare the findings with the existing literature in order to assist students and health professionals working in this field.

Materials and Methods

The study was done in 50 human specimens, 22 were done in the dissection hall cadavers, and 28 were collected from the post-mortem among the sound Indian inhabitants regardless of age and sex. The investigation was conducted in the Department of Anatomy at the Kurnool Medical College, Kurnool, and Apollo Institute of Medical Sciences, Chittoor. No specific institutional ethics committee permission was required because these findings were discovered during a normal dissection study for first-year medical students. Following the guidelines in the second volume of Cunningham›s Dissection Manual, the abdomen was opened. The stomach and lesser omentum attached along the lesser curvature and also attachment to the porta hepatis was identified. The arteries which were entering the liver traced toward their source of origin. In each instance, a schema was drawn. The source of origin, course, and relations of the hepatic artery in special referee with the relation of the artery with hepatic ducts were examined and documented.

Results

Common Hepatic Artery (CHA)

Out of 50 specimens studied, variations in the origin and course of the common hepatic artery were observed in 1 of the 50 specimens, amounting to 2% (1/50), it took replaced the origin from the abdominal aorta (Figure 1A). The remaining 49 cadavers showed classical origin and course of hepatic arteries (49/50=92%).

Proper Hepatic Artery (PHA)

Common hepatic artery after giving gastroduodenal artery (GDA) ascended as a proper hepatic artery which divided into right and left hepatic arteries. This classical pattern was observed in 36, specimens, amounting to 72% (36/50). In the rest of the 14 (28%) specimens, the proper hepatic artery was not noted and the branching pattern differed as follows:

Trifurcation of Common Hepatic Artery:

The common hepatic artery was trifurcated into the gastroduodenal artery, right hepatic artery (RHA), and left hepatic artery (LHA) in 4 specimens out of 14 variant specimens, accounting for 28.5% of proper hepatic artery variants and 8% of all specimens (Figure 1B).

Continuation of common Hepatic Artery as Right Hepatic Artery Alone:

In 2 (4%) specimens of total and 14.2% of variants, the common hepatic artery after giving gastroduodenal artery, just continued as the right hepatic artery alone, without the intermediation of the proper hepatic artery. In those 2 specimens, the left hepatic artery had replaced the origin.

Continuation of common Hepatic Artery as Left Hepatic Artery Alone:

In the highest number accounting for 8 specimens

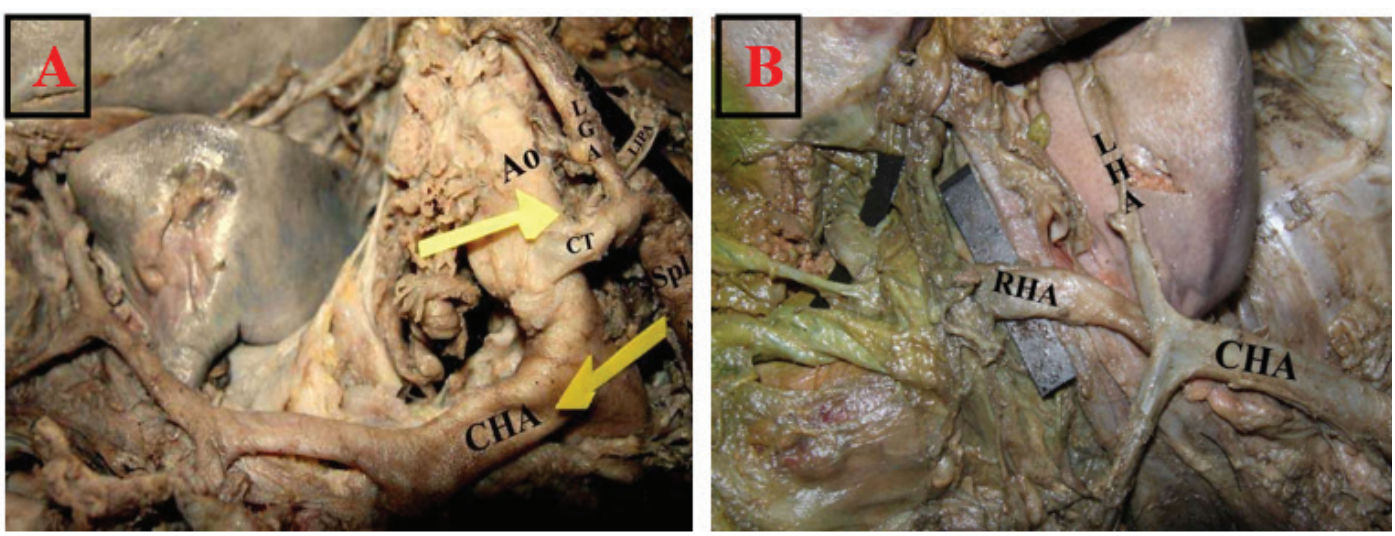

Figure 1. A) Common hepatic artery branch from Aorta B) Common hepatic artery trifurcated into the gastroduodenal artery, right hepatic artery, and left hepatic artery

(57.1% of variants, 16% of total), the common hepatic artery after giving gastroduodenal artery, just continued as the left hepatic artery alone, without the interference of the proper hepatic artery. In those 8 specimens, the right hepatic artery had replaced the origin.

Right Hepatic Artery (RHA):

In 37 (74%) specimens, the right hepatic artery originated from the proper hepatic artery, the CHA in 4 (8%) specimens, and it replaced the origin in the remaining 9 (18%) specimens. Those are as follows Replaced RHA from the superior mesenteric artery (SMA) in 5 specimens (10%) (Figure 2A), from the GDA in 5 specimens (10%) (Figure 2B), Double replaced RHA from the GDA in 1 specimen (2%) (figure 2C), Replaced common hepatic artery in 1 specimen (2%). In all 6 of the aforementioned cases, the replaced right hepatic artery of superior mesenteric artery origin ran abnormally posterior to the head of the pancreas and rose posterior to the portal vein in the right free margin of the lesser omentum (figure 2A).

Aberrant Right Hepatic Artery:

Aberrant hepatic artery includes accessory and replaced hepatic arteries. In this study, the aberrant right hepatic artery was noticed in 13 specimens, of which replaced the right hepatic artery was seen in 9 specimens and the accessory right hepatic artery was noticed in 4 specimens. The source of aberrant right hepatic arteries was noted as follows:

Replaced Right Hepatic Artery:

Out of 9 specimens, the source of origin was as follows: In 5 (10%) specimens, it took origin from the superior mesenteric artery (Figure 2A). In 2 (4%) specimens, it took its origin from the gastroduodenal artery (Figure 2B). In 1 (2%) specimen, two replaced right hepatic arteries took origin from the superior mesenteric artery and gastroduodenal artery (Figure 2C). In 1(2%) specimen, it took origin from the proper hepatic artery of replaced common hepatic artery. The replaced right hepatic artery of the superior mesenteric artery origin, in all the above 6 specimens, ran unusually posterior to the head of the pancreas

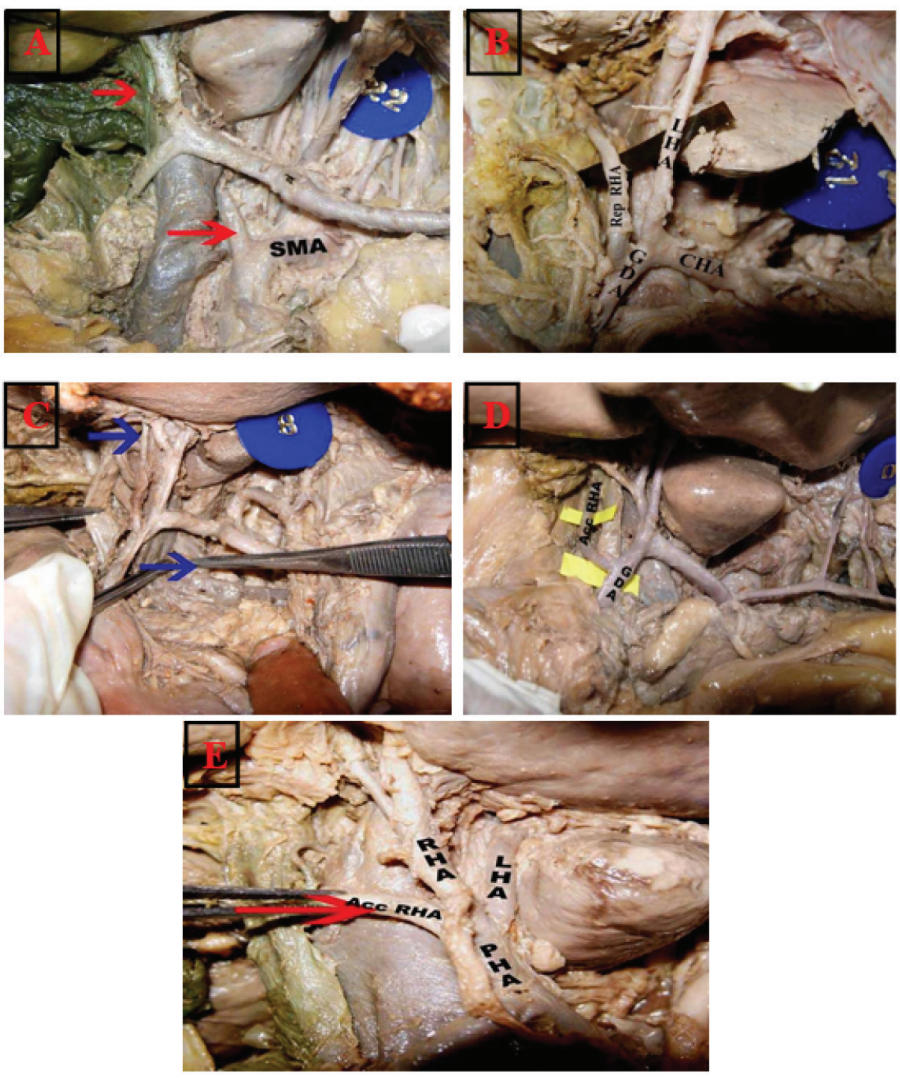

Figure 2. Representative photographs showing A) Replaced RHA from the superior mesenteric artery, B) Replaced RHA from the gastroduodenal artery, C) RHA from the gastroduodenal artery, D) AccessoryRHAfromgastroduodenalartery E) AccessoryRHAfrom the properhepaticartery.

and ascended posterior to the portal vein in the right free margin of the lesser omentum (Figure 2A).

Accessory Right Hepatic Artery:

Out of 4 (8%) specimens, the source of origin was as follows: In 3 (6%) specimens, it took origin from the gastroduodenal artery (Figure 2D). In 1 (2%) specimen, it took origin from the proper hepatic artery (Figure 2E).

Left Hepatic Artery:

The left hepatic artery took origin from the proper hepatic artery in 43 (86%) specimens, from the common hepatic artery in 4 (8%) specimens, and in the rest of the 3 (6%) specimens, it had replaced the origin. 8% from the common hepatic, 4% from the left gastric artery 2% from the hepatic artery of replaced common haptic artery.

Aberrant Left Hepatic Artery:

An abnormal left hepatic artery was seen in 3 individuals. All were replaced with the left hepatic artery, out of which, In 2 (4%) specimens, the replaced left hepatic artery took origin from the left gastric artery (Figure 3A). In 1(2%) specimen, it took its origin from the proper hepatic artery of replaced common hepatic artery.

Middle Hepatic Artery:

In 31 specimens, the middle hepatic artery was seen. Out of which, In 16 specimens, it took origin from the right hepatic artery (Figure 3B). In 11 specimens, it took origin from the left hepatic artery (Figure 3C). In 4 specimens, it took origin from the proper hepatic artery (Figure 3D).

Other Branches of Hepatic Artery

Gastroduodenal Artery:

In all the 50 specimens, it took origin from the common hepatic artery. Among these 50 specimens, 1 (2%) specimen, took origin from the common hepatic artery of aortic origin. The right gastroepiploic artery, which follows the larger curvature of the stomach, was detected in 98% of cases. In 3 (6%) specimens, it gave origin to replaced right hepatic artery (Figure 2B). In another 3 (6%) specimens, it gave origin to the accessory right hepatic artery (Figure 2E).

Right Gastric Artery:

The origin of the right gastric artery was observed as follows: From the proper hepatic artery in 25 (50%) specimens (Figure 4A). From the left hepatic artery in 15 (30%) specimens (Figure 4B). From the gastroduodenal artery in 6 (12%) specimens (Figure 4C). From the right hepatic artery in 3 (6%) specimens (Figure 4D). From the common hepatic artery in 1 (2%) specimen.

Figure 3. Representative photographs showing A) Replaced left hepatic artery took origin from the left gastric artery, B) Middle Hepatic Artery from the right hepatic artery, C) Middle Hepatic Artery from the left hepatic artery, D) Middle Hepatic Artery from the proper hepatic artery

Cystic Artery:

The cystic artery arose from the right hepatic artery it was observed in 39 (78%) specimens. In 10 (20%) specimens, it took origin from the aberrant right hepatic artery. Out of which in one specimen (2%), two cystic arteries arose separately from the two replaced right hepatic arteries of the gastroduodenal artery and superior mesenteric artery (Figure 4C). In 1 specimen, it took origin from the gastroduodenal artery (Figure 4E).

Discussion

When performing an abdominal intervention, the surgeon must have a thorough understanding of the hepatic vascular architecture[5]. It is well known that variances in the vasculature result from changes that occur at various phases of embryonic development. Particularly in liver transplantation, careful identification of the graft's anatomy at the time of organ capitulation is necessary to facilitate the graft's complete arterialization[4,8,9].

Therefore, standard vascular architecture will act as a guide to appreciating the vascular supply and graft drainage[8]. The hepatic lobes can get blood from other arteries as accessories, happening in addition to the regular blood supply, or in a substitutive mode, serving as the only primary lobe artery supply, in circumstances of anatomical abnormalities[4].

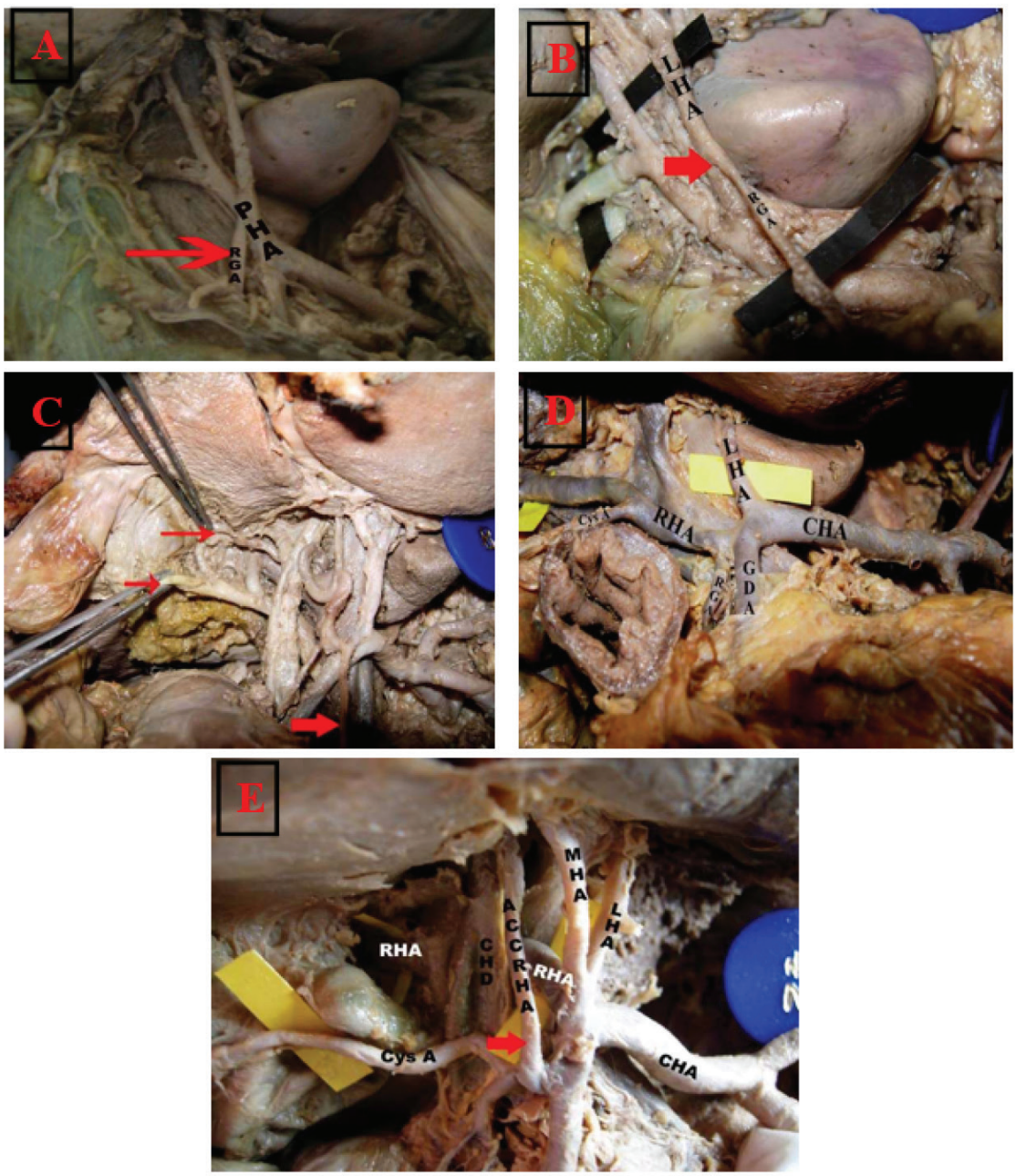

Figure 4. Representative photographs showing the Right gastric artery from A) Proper hepatic artery B) Left hepatic artery, C) Gastroduodenal artery D) right hepatic artery E) Common hepatic artery.

Multiple anatomical variants were classified into 10 categories by Michels in 1966, in a study of 200 dissections1[5], which is a reference to the present day for most studies[5,7]. This classification was modified by Hiatt in 1994[16], which, as opposed to Michels (Nicholas A Michels, 1966), divided it into six groups without distinguishing between auxiliary or hepatic arterial replacement structures[15]. Hiatt classification [16] is simpler and frequently applied when the analysis is performed using angiographic studies since it is considered difficult to distinguish between angiographically ancillary substitutes or vascular structures[17]. In this study, both classifications were used.

The research states that 20–50% of people have anatomical differences[7]. Digital angiography was used to analyze 152 liver transplant recipients by Zagyapan *et al*., who observed 37.5 variants of the hepatic artery anatomy[8]. 24.3% of hepatic artery alterations were discovered by Hiatt *et al*. (Hiatt *et al*., 1994) in a group of 1000 patients who received liver transplants[16]. In a series of 1200 cases, Kobayashi *et al*.[5] identified normal hepatic arterial anatomy in 77.2%, and 22.8% of anatomic variations. In this study, 50 cadavers (86.8%) had normal anatomy (Type I) in 72% (36/50), In the rest of the 14 (28%) had some sort of variation, being this percentage the lowest prevalence among studies.

According to Michels categorization, the type III variation (RHA branch from SMA), which occurs in 6.5%–15.5% of cases, is the most common variation[17]. It stands out as the most important because it has the potential to affect surgical procedures being indispensable in its identification[7]. In agreement with the literature, in this study also 10% of cases observed this variation. The second most frequent type is type II (LHA branch of LGA), which has been seen in 2 (4%) specimens in the current research and has been recorded in the literature to occur in 2.5–10% of cases. The replaced left hepatic artery originated from the left gastric artery. Type IV is described with an incidence of 1-7.4%[18] 2, and here it was not found. Types VII, VIII, IX, and X are rarely described in the literature[17] not being observed in this research. In terms of Hiatt classification, type III was observed in 6.05% of cases, and type II was observed in 16 cases (3.34%), with type II being the most common in other research[3,8].

A comprehensive categorization, however, cannot account for all kinds because anatomical differences may result from genetic aberrations during the embryonic stage. Patients were found to have uncommon abnormalities (2.92%) that weren't classified by Michels and Hiatt[8].

According to several studies that have documented anatomical differences in 20.9%–45% of cases, the literature demonstrates that hepatic arterial variants are frequent[15,19–21]. Variations previously described in which the proper hepatic artery was absent include: common hepatic artery trifurcation into the gastroduodenal artery, left hepatic artery, and right hepatic artery[20,22], and the common hepatic artery dividing into right and left hepatic arteries, with the gastroduodenal artery originating from the right hepatic artery[23]. The Calot's triangle is more vulnerable to iatrogenic injuries as a result of an unusual case described by Shetty *et al*.[24] in which the common hepatic artery gave rise to a second right hepatic artery coursing in the triangle. According to recent research, the common hepatic artery split into two branches: a common short trunk for the right stomach and liver arteries (the hepatogastric trunk), and hepato-gastro-duodenal trunk, a common trunk for the hepatic arteries and gastroduodenal arteries.The right hepatic artery w as passing on the right posterior side of the cystic duct and giving the cystic artery[25].

Origin of Common Hepatic Artery:

Daseler *et al*., (1947) reported that the incidence of origin of the common hepatic artery from the coeliac trunk was 83.2% [26]. In the present study, the incidence was 98%. Origin of common hepatic artery from the aorta was reported as follows, by Rossi and Cova (1904) in 3.9%[27], in 0.2%[26], in 0.2%[16], in 1.08%[28]. In the current study, in 2% of specimens, the common hepatic artery took origin from the aorta which is similar to that of Shoumura *et al*., study.

Trifurcation of Common Hepatic Artery:

Trifurcation of the common hepatic artery into the right hepatic left hepatic and gastroduodenal artery was observed by Margaret Kemeny *et al*., (1986) in 9% of cases[29], by Bartevello P.L *et al*., (2002) in 15%[30]. In this study, the incidence was 8%, which is similar to that of Margaret Kemeny *et al*., study.

Right Hepatic Artery:

E.R.Flint (1922-23) in 79%[12], Daseler *et al*., (1947) in 83.2%[26], and Dorvan A Moosman *et al*., (1951) in 85.6%[31], Arjhansiri K *et al*., (2006) in 80.5%[32] of specimens observed the right hepatic artery taking origin from the normal coeliac hepatic artery. In my study, the incidence was noted in 82% of the specimens which is similar to Daseler *et al*., study.

Aberrant Right Hepatic Artery:

Daseler *et al*., (1947) in 24% out of 500 specimens[26], Dorvan A Moosman *et al*., (1951) in 18.4% out of 250 specimens[31], Edward V Johnson *et al*., (1952) in 20% out of 35 specimens[33], observed the presence of aberrant right hepatic artery. In the current study, it was noticed in 13 out of 50 specimens - 26% which is closely similar to Daseler *et al*., study.

Replaced Right Hepatic Artery:

Dorvan A Moosman *et al*., (1951) observed replaced right hepatic artery in 36 out of 250 specimens, 14.4%[31]. Margaret M Kemeny *et al*., (1986) observed it in 20 out

of 100 specimens, 20%[29]. In my study, it was found in 9 out of 50 specimens, 18%, which is similar to Margaret M Kemeny *et al.*, study.

Replaced Right Hepatic Artery of Superior Mesenteric Artery:

Daseler *et al.*, (1947) in 11.2%[26], Edward V Johnson *et al.*, (1952) in 8.6%[33], Michels (1955) in 11%[34], Nakayasu *et al.*, (2000) in 10.2%[35], Arjhansiri K *et al.*, (2006) in 11.5%[32] found the replaced right hepatic artery from the SMA. In this study, the incidence was 12%, which is similar to Daseler *et al.*,[26] and Arjhansiri *et al.*,[32] study and closer to Michels study.

John M Pierson (1943) and Michles (1955)[34,36] observed that all the aberrant right hepatic arteries of superior mesenteric artery origin coursed behind the pancreas. Higashi N Hirari (1955), Kahraman G *et al.*, (1984) reported that aberrant right hepatic artery of superior mesenteric origin had an unusual course of running posterior to the portal vein[37,38]. In my study also, all the aberrant right hepatic arteries of superior mesenteric origin (12%) coursed posterior to the head of the pancreas and posterior to the portal vein.

Replaced Right Hepatic Artery from Replaced Common Hepatic
Artery of Aorta:

Daseler *et al.*, (1947) reported this type of variation in 1 out of 500 specimens at 0.2%[26]. In the current study, it was noticed in 1 out of 50 specimens (2%).

Accessory Right Hepatic Artery:

Daseler *et al.*, (1947) documented in 7.2%[26], Dorvan A Moosman *et al.*, (1951) in 4% of specimens observed the presence of accessory right hepatic arteries[31]. In this study, it was observed in 8% which is similar to Daseler *et al.*, study.

Accessory Right Hepatic Artery from Gastroduodenal Artery:

Daseler *et al.*, (1947) noticed this artery in 5 out of 500 specimens - 1%[26]. Futura Ali *et al.*, (2001) noticed it in 2% of the specimens[39]. In our study, it was noticed in 3 out of 50 specimens - 6%, which is nearer to that of Futura Ali *et al.*, study.

Left Hepatic Artery:

Daseler *et al.*, (1947) in 87%[26], Edward V Johnson *et al.*, (1952) in 91.4%[33] of the specimens observed the origin of the left hepatic artery from a normal coeliac hepatic artery. In my study, the incidence was noted to be 94% of the specimens, which is nearer to that of the Edward V Johnson study.

Replaced Left Hepatic Artery from Left Gastric Artery:

Margaret M Kemeny *et al.*, (1986) observed the presence of replaced left hepatic artery from the left gastric artery in 4 out of 100 specimens - 4%[29]. Arjhansiri K *et al.*, 2006) observed it in 5.5% of cases[32]. In the present study, it was observed in 2 out of 50 specimens - 4%, which coincides with the result of the Margaret M Kemeny *et al.*,[29] study.

Aberrant Hepatic Artery:

Thompson (1933) found aberrant hepatic arteries in 28% of cases[40]. In this study, the incidence was 32%, which is closely similar to the above study.

Middle Hepatic Artery:

Adachi (1928) reported the origin of the middle hepatic artery from the right hepatic, left hepatic, and proper hepatic artery in 50%, 40%, and 10% respectively[13]. Michles (1955) observed its origin from the right hepatic, left hepatic, and proper hepatic artery in 45%, 45%, and 10% respectively[14]. In this research, 31 tissues (62%) contained the origin of the middle hepatic artery. Out of which, its origin from the right hepatic, left hepatic, and proper hepatic artery was seen in 32%, 22%, and 8% of the specimens respectively, and in the rest of the 38% of the specimens, the middle hepatic artery was not noticed.

Classification of Hepatic Artery:

Jonathen (1994) classified the hepatic artery into 5 types. According to him, out of 1000 specimens studied, 75%, 9.7%,10.6%, 4.5%, and 0.2% of specimens belonged to Type I, II, III, IV, and V. In my study, out of 50 specimens, 70% belonged to Type I, 4% to Type II, 12% to Type III, and 2% to Type V, and Type IV specimens were not noticed in any of the specimens. The rest of the 12% of specimens could not be classified under Jonathen study, out of which the right and left hepatic artery arose from a common hepatic artery in 8%, and the right hepatic artery took replaced the origin from the gastroduodenal artery in 4% of specimens[16].

Other Branches of Hepatic Artery
Gastroduodenal Artery:

Daseler *et al.*, (1947) observed that this artery took origin from a common hepatic artery in 75.4%, from replaced common hepatic artery in 3.6%, from a right hepatic artery in 7%, from the coeliac trunk in 2.5%, from the aorta in 0.2% and absent in 2.8%[26]. Edward V Johnson *et al.*, (1952) reported its origin from the common hepatic artery in all the cases[33]. In this study, it took origin from the common hepatic artery in all the specimens; among which one of the specimens, took its origin from the replaced common hepatic artery of the aorta.

Right Gastric Artery:

Daseler *et al.* (1947) noted that the right gastric artery originates from the proper hepatic artery, left hepatic artery, gastroduodenal artery, and right hepatic artery[26] in 50%, 32.4%, 13.2%, and 4%, by Michels

(1955) in 40%, 40.5%, 8%, and 5.5% respectively[14]. In our study, its origin from 333 the proper hepatic artery, left hepatic artery, gastroduodenal artery, and right hepatic artery was observed to be 50%, 30%, 12%, and 6% respectively. The findings of the present study are similar to that of Daseler *et al*.,[26] study. Eckmann I Krahn (1984) observed its origin from the common hepatic artery in 4% of specimens[41]. In my study, in 1 specimen - 2%, it took origin from the common hepatic artery, which is closely similar to the above study.

Cystic Artery:

According to Daseler *et al*. (1947), the cystic artery originates from the right hepatic artery in 84.4% of cases, an abnormal right hepatic artery in 12.7% of cases, and other origins in 3% of cases[26]. Dorvann A Moosman *et al*., (1951)[31] observed the origin of cystic artery from the right hepatic artery in 86%, aberrant right hepatic artery in 10%, and from other sources in 4%[31]. Michels (1955) observed the origin of cystic artery from the right hepatic artery in 78%, aberrant right hepatic artery in 18%, and from other sources in 5%[14]. In our study, its origin was found to be from the right hepatic artery in 78%, from an aberrant right hepatic artery in 20%, and other sources like the gastroduodenal artery in 2%. The findings are closely similar to that of Michels study.

In order to prevent damage and vascular surgical complications, surgeons must have a precise understanding of the most common and rare variations that produce different technical difficulties, or challenges. Studies of hepatic arterial anatomy using case series of liver transplants and studies of anatomical differences in cadavers demonstrate significant variation in the grafts, cautioning the need for care in surgery dissections, striving for effective arterialization, and, subsequently, the success of the operation.

Conclusion

In operations like gastric resection, partial hepatectomy, especially in liver transplantation, and operations near the gastrohepatic ligament, including esophagogastrectomy, gastric bypass, and anti-reflux treatments, the Coeliac trunk and its branches are important (42). Since they might be prospective bleeding sites or potentially the only source of vascularity, it is critical to have up-to-date information on whether auxiliary or replacement structures exist.

References

1. Koshariya M, Khare V, Songra MC, Shukla S, Gupta A. Anomalous Anatomical Variations of Coeliac Trunk: A Cadaveric Study. Cureus 2021; 13(10).
2. 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.
3. Freitas ACT de, Coelho JCU, Matias JEF, Zeni Neto C, Martins EL, Druszcz CC. Anatomia Arterial Hepática: Estudo Em 150 Transplantes Hepáticos. Rev. Col. Bras. Cir. 2001; 28: 13–16.
4. Sebben GA, Rocha SL, Sebben MA, Parussolo Filho PR, Gonçalves BHH. Variations of Hepatic Artery: Anatomical Study on Cadavers. Rev. Col. Bras. Cir. 2013; 40: 221–226.
5. Kobayashi S, Otsubo T, Koizumi S, Ariizumi S, Katagiri S, Watanabe T, Nakano H, Yamamoto M. Anatomic Variations of Hepatic Artery and New Clinical Classification Based on Abdominal Angiographic Images of 1200 Cases. Hepatogastroenterology. 2014; 61: 2337–2340.
6. Andraus W, Haddad LBP, Ducatti L, Martino RB, Santos VR, D'Albuquerque LAC. Reconstrução Arterial No Transplante Hepático: A Melhor Reconstrução Para Variação Da Artéria Hepática Direita. ABCD. Arq. Bras. Cir. Dig. (São Paulo) 2013; 26: 62–65.
7. Sebben GA, Rocha SL, Sebben MA, Parussolo Filho PR, Gonçalves BHH. Variações Da Artéria Hepática: Estudo Anatômico Em Cadáveres. Rev. Col. Bras. Cir. 2013; 40: 221–226.
8. 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 2014; 25(1): 104–109.
9. Andraus W, Haddad LBP, Ducatti L, Martino RB, Santos VR, D'Albuquerque LAC. Artery Reconstruction in Liver Transplantation: The Best Reconstruction of Right Hepatic Artery Variation. ABCD. Arq. Bras. Cir. Dig. (São Paulo) 2013; 26: 62–65.
10. Von Haller A. Icones Anatomicae Quibus Praecipuae Aliquae Parte Corporis Humani Delineatae Propununtur et Arteriarum Potissimum Historia Continetur, vol. 1. Vanden Hoeckii 1756.
11. Tiedemann F. Friderici Tiedemann... Tabulae Arteriarum Corporis Humani. ex officina Christiani Friderici M 1822.
12. Flint ER. Abnormalities of the Right Hepatic, Cystic, and Gastroduodenal Arteries, and of the Bile-Ducts. Br. J. Surg. 1923; 10(40): 509–519.
13. Adachi B. Das Arteriensystem Der Japaner. Band 1928.
14.Michels NA. Blood Supply and Anatomy of the Upper Abdominal Organs: With a Descriptive Atlas. Lippincott 1955.
15. Michels NA. Newer Anatomy of the Liver and Its Variant Blood Supply and Collateral Circulation. Am. J. Surg. 1966; 112(3): 337–347.
16. Hiatt JR, Gabbay J, Busuttil RW. Surgical Anatomy of the Hepatic Arteries in 1000 Cases. Ann. Surg. 1994; 220(1): 50.
17. Ugurel MS, Battal B, Bozlar U, Nural MS, Tasar M, Ors F, Saglam M, Karademir I. Anatomical Variations of Hepatic Arterial System, Coeliac Trunk and Renal Arteries: An Analysis with Multidetector CT Angiography. Br. J. Radiol. 2010; 83(992): 661–667.
18. Chen H, Yano R, Emura S, Shoumura S. Anatomic Variation of the Celiac Trunk with Special Reference to Hepatic Artery Patterns. Ann. Anatomy-Anatomischer Anzeiger 2009; 191(4): 399–407.
19. Koops A, Wojciechowski B, Broering DC, Adam G, Krupski-Berdien G. Anatomic Variations of the Hepatic Arteries in 604 Selective Celiac and Superior Mesenteric Angiographies. Surg. Radiol. Anat. 2004; 26: 239–244.
20. Abdullah SS, Mabrut J-Y, Garbit V, De La Roche E, Olagne E, Rode A, Morin A, Berthezene Y, Baulieux J, Ducerf C. Anatomical Variations of the Hepatic Artery: Study of 932 Cases in Liver Transplantation. Surg. Radiol. Anat. 2006; 28: 468–473.
21. Winter 3rd TC, Nghiem H V, Freeny PC, Hommeyer SC, Mack LA. Hepatic Arterial Anatomy: Demonstration of Normal Supply and Vascular Variants with Three-Dimensional CT Angiography. Radiographics 1995; 15(4): 771–780.
22. Nayak SB, Vasudeva SK. Vascular Variations of Liver and Gallbladder: A Case Report. Anat. \& Cell Biol. 2013; 46(3): 217–219.
23. Badagabettu SN, Sirasanagandla SR, Kumar N, Shetty SD.

Hepatosplenic Trunk Associated with Tortuous Course of Right Hepatic Artery Forming Caterpillar Hump. N. Am. J. Med. Sci. 2012; 4(8): 376.
24. Shetty P, Nayak SB, D'Souza MR. Rare Type of Course and Distribution of an Additional Right Hepatic Artery: A Possible Source of Iatrogenic Injury during Hepato-Biliary and Pancreatic Surgeries. Online J Heal. Allied Scs 2017; 16(2): 18.
25. Umugwaneza N, Byiringiro F, Ndahimana P, Ivang A, Nyundo M, Ntirenganya F, Gashegu J. Unusual Anatomical Variations of the Hepatic Arteries and Bile Ducts: What Are the Surgical Implications. Afr. Health Sci. 2022; 22(3): 697–702.
26. Daesler EH, Anson BJ, Hambley WC, Reiman AF. The Cystic Artery and Constituents of the Hepatic Pedicle. Surg. Gynecol. Obs. 1947; 85: 47.
27. Rossi G. Studio Morfolgico Delle Arterie Dello Stomaco. Arch Ital Anat Embriol 1904; 3: 485–657.
28. Shoumura S, Emura S, Utsumi M, Chen H, Hayakawa D, Yamahira T, Isono H. Anatomical Study on the Branches of the Celiac Trunk (IV). Comparison of the Findings with Adachi's Classification. Kaibogaku Zasshi. 1991; 66(5): 452–461.
29. Kemeny MM, Hogan JM, Goldberg DA, Lieu C, Beatty JD, Kokal WA, Riihimaki DU, Terz JJ. Continuous Hepatic Artery Infusion with an Implantable Pump: Problems with Hepatic Artery Anomalies. Surgery 1986; 99(4): 501–504.
30. Bertevello PL, Chaib E. Hepatic Artery System Variations Correlated to Split-Liver Surgery: Anatomic Study in Cadavers. Arq. Gastroenterol. 2002; 39: 81–85.
31. Moosman DA, Coller FA. Prevention of Traumatic Injury to the Bile Ducts: A Study of the Structures of the Cystohepatic Angle Encountered in Cholecystectomy and Supraduodenal Choledochostomy. Am. J. Surg. 1951; 82(1): 132–143.
32. Arjhansiri K, Charoenrat P, Kitsukjit W. Anatomic Variations of the Hepatic Arteries in 200 Patients Done by Angiography. J. Med. Assoc. Thailand= Chotmaihet Thangphaet 2006; 89: S161--8.
33. Johnston E V. Variations in the Formation and Vascular Relationships of the Bile Ducts. Surg Gynecol Obs. 1952; 94: 669–686.
34. Michels NA. The Variational Anatomy of the Spleen and Splenic Artery. Am. J. Anat. 1942; 70(1): 21–72.
35. Ohgiya Y, Gokan T, Munechika H. Demonstration of Aberrant Hepatic and Gastric Arteries with Helical CT. Invest. Radiol. 1999; 34(9): 579.
36. Pierson JM. The Arterial Blood Supply of the Pancreas. Surg Gynecol Obs. 1943; 77: 426–432.
37. Kahraman G, Marur T, Tanyeli E, Yildirim M. Hepatomesenteric Trunk. Surg. Radiol. Anat. 2002; 23: 433–435.
38. Nishiguchi T, Kitamura S, Matsuoka K, Sakai A. A Case of the Three Branches of the Coeliac Trunk Arising Directly from the Abdominal Aorta. Kaibogaku Zasshi. 1988; 63(6): 553–556.
39. Futara G, Ali A, Kinfu Y. Variations of the Hepatic and Cystic Arteries among Ethiopians. Ethiop. Med. J. 2001; 39(2): 133–142.
40. Thompson IM. On the Arteries and Ducts in the Hepatic Pedicle, a Study in Statistical Human Anatomy, by I. Maclaren Thompson. University of California Press 1933.
41. Eckmann I, Krahn V. Frequency of Different Sites of Origin of the Right Gastric Artery. Anat. Anz. 1984; 155(1–5): 65–70.
42. Silveira LA, Silveira FBC, Fazan VPS. Arterial Diameter of the Celiac Trunk and its Branches. Anatomical Study. Acta Cir. Bras. 2009; 24(1): 43-47.

Received: November 5, 2023
Accepted: January 10, 2024

Corresponding author
Jyothi Ashok Kumar
E-mail: jyothiashok.anatomist@gmail.com