"VARIATIONS IN THE ORIGIN OF COMMON HEPATIC ARTERY USING MULTIDETECTOR COMPUTED TOMOGRAPHY ANGIOGRAPHY"

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ABSTRACT

Background:The common hepatic artery (CHA) is a crucial component of the hepatic arterial system, delivering blood to the liver, stomach, duodenum, and gallbladder. It helps to understand its structural changes for both therapeutic and diagnostic purposes, especially in interventional radiology and surgical planning.

Materials and methods: This study was conducted prospectively at KLES Dr. Prabhakar Kore Hospital and Medical Research Center in Belagavi, Karnataka, India, from August 2021 to May 2022. 578 cases, including 360 males and 218 females, ages 7 to 80, underwent abdominal contrast-enhanced multiphasic computed tomography (CT) scans examined. A GE Revolution EVO 128 multislice CT scanner with a 1.5 mm section thickness was applied for the scans to allow to enhance the origin common hepatic artery visualization.

Results: The 30 patients (5.2%) exhibited variations in the common hepatic artery (CHA) origin. The majority of cases, 548 (94.8%), showed the CHA originating from the celiac artery (CA), which is considered the normal anatomy. Variations in the common hepatic artery (CHA) included 7 cases (1.2%) where it originated from the superior mesenteric artery (SMA) and 23 cases (4%) where it arose directly from the aorta.

Conclusions: The celiac artery serves as the primary source of the common hepatic artery (CHA) across all age groups and genders, while contributions from the aorta and superior mesenteric artery (SMA) are minimal. In order to improve surgical accuracy and diagnostic techniques during liver procedures, this understanding is crucial.

Keywords- Common hepatic artery, Anatomical variations, Multidetector computed tomography.

Introduction:

The common hepatic artery, a branch of the celiac trunk, travels downward behind the lesser sac toward the upper border of the first segment of the duodenum. After branching into the gastroduodenal artery, it continues as the proper hepatic artery. The proper hepatic artery then ascends within the free margin of the lesser omentum to reach the porta hepatis, where it divides into the left and right hepatic arteries, supplying the liver lobes[1].

To ensure safe and effective liver surgery during partial liver resection for living donor transplants, a thorough understanding of the hepatic angioarchitecture is necessary. Understanding hepatic artery variations prior to surgery can help in treatment selection, surgical dissection, and preventing iatrogenic injury[2, 3.]

The gastrointestinal system receives arterial blood supply from the anterior branches of the abdominal aorta at three distinct levels: the celiac trunk, superior mesenteric artery, and inferior mesenteric artery. These vascular systems vary in a variety of ways due to differences that arise throughout various developmental stages of the embryonic phase. Assessing hepatic arterial anatomy before surgery is essential for patients undergoing living-donor liver transplants or extensive hepatic resections for primary or metastatic liver tumors, as accidental damage to the arterial supply can lead to ischemic complications[4, 5].

One technique that shows promise for identifying vascular anatomy is three-dimensional (3D) helical computed tomography angiography. By clearly illustrating the normal anatomy and vascular variations, this approach helps to define the arterial anatomy of the liver[6].

Material and Methods:

Study design: A case series study.

The current study was conducted in the Department of Radiodiagnosis at KLES Dr. Prabhakar Kore Hospital and Medical Research Center in Belagavi.

Source of data collection: The patient was sent to the Department of Radiodiagnosis for a contrast-enhanced multiphase abdominal CT scan.After obtaining consent from the patients, they were recruited for the study. A patient information sheet, which contained brief information about the research study, was also provided to the study subjects.

Sample size: 578

- 578 cases were evaluated, which included 360 males and 218 females, aged between 7 and 80 years.

Inclusion Criteria:

- Patients of all ages and genders referred for contrast-enhanced multiphase abdominal computed tomography for various clinical reasons.

Exclusion Criteria:

• Patients who had significant upper abdominal surgery in the past.

• Patients who had hepatic artery thrombosis

Equipment: GE Bright speed 128 slice CT scanner and Pressure injector (Medrad).

CT imaging processing: Beginning with plain scans and progressing to contrast multiphasic scans, the axial plane was scanned from the diaphragm's domes to the pubic symphysis. Post-processing was performed using volume rendering technique (VRT), maximum intensity projection (MIP), and multiplanar reconstruction (MPR).

Scanning parameters: Thickness of the slice: 1.25mm

Thickness (mm)	Interval (mm)	Matrix	Pitch no.	Speed	Rotation Time	kV	mA(Auto)	Fov

6.25	0.625	1024×1024	0.984	39.37mm/rot	0.8s.	120	10-560	large

Contrast medium: An iodinated contrast agent (Iohexol) with a concentration of 350 mg/ml of iodine was administered at a dose of 80–100 ml (2–3 ml per kg of body weight) at a rate of 3–4 ml per second using an automated power injector.

Image interpretation:

The common hepatic artery origin was analysed individually and recorded using standard classification system.

Statistical Analysis: Statistical Analysis: Data analysis was performed using version 22 of the Statistical Package for Social Sciences (SPSS). Variations in the origin of the common hepatic artery (CHA) across different gender and age groups were assessed through an observational analysis utilizing 128-slice multidetector computed tomography (MDCT).

Results:

Table 1. The variations in the origin of the Common Hepatic Artery

CHA Origin	Number of cases	%
From CA	548	94.8
From Aorta	23	4
From SMA	7	1.2
Total	**578**	**100**

The analysis of 578 cases, as presented in Table 1, reveals variations in the origin of the common hepatic artery (CHA). The celiac artery is the primary source of the CHA in 94.8% of cases, as illustrated in Figures 1 and 2. Variations include the CHA arising from the aorta in 4.0% of cases (Fig. 4) and from the superior mesenteric artery (SMA) in 1.2% of cases (Fig. 5).These findings highlight the predominance of the celiac artery as the CHA source, with limited but clinically relevant anatomical variations.

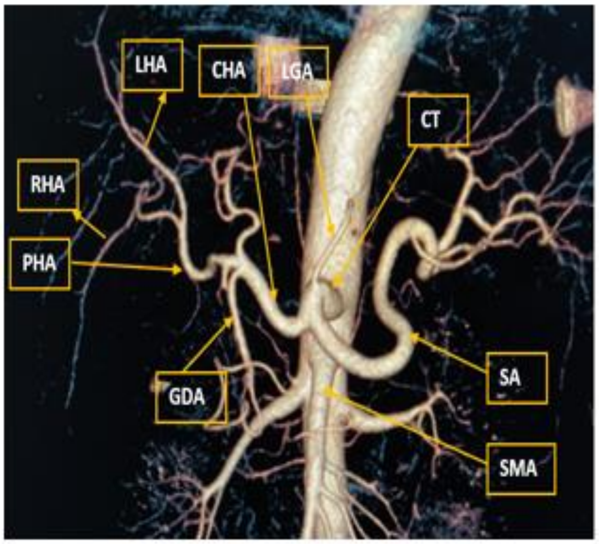

Fig: 1 Volume rendering image showing normal Hepatic arterial system.

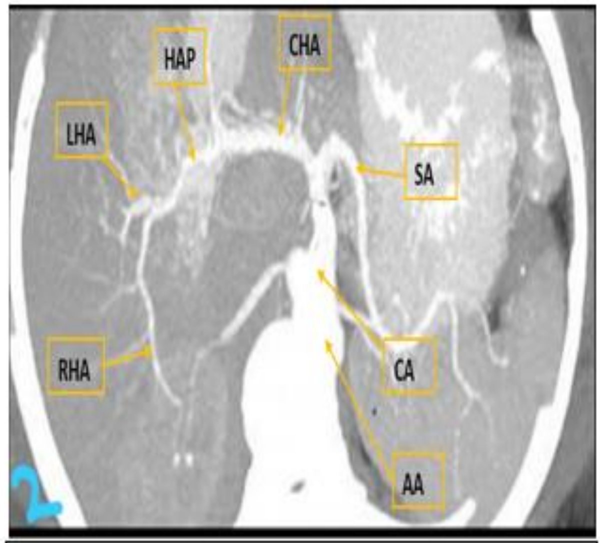

Fig: 2 Maximum intensity projection image showing normal hepatic arterial system.

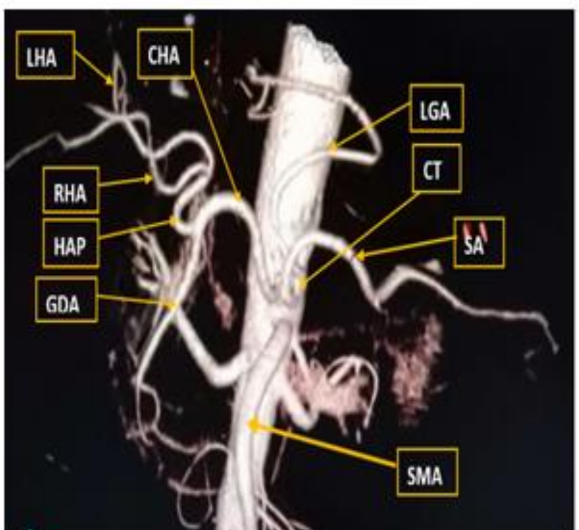

Fig: 4 Volume rendering image showing origin of CHA from Aorta

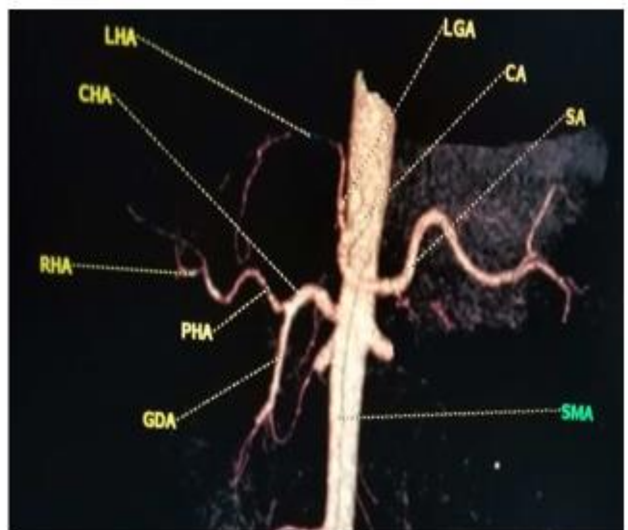

Fig: 5 Volume rendering image showing origin of CHA from SMA

Table 2. Association of CHA origin with gender.

Demographic Variable		**CHA origin**				**Chi-square value**	**p-value**
		Normal		**Variations**			
		n	**%**	**n**	**%**		
Gender	**Male**	335	93.1	25	6.9	5.968	0.015*
	Female	213	97.7	5	2.3		

Table 2 showsthe association between gender and CHA origin was examined using a chi-square test. Among males, 93.1% had normal CHA origin, and 6.9% exhibited variations. In females, 97.7% had a typical origin of the CHA, while 2.3% showed variations. A statistically significant association between CHA origin and gender was found, as indicated by the chi-square test (χ^2 = 5.968, p = 0.015).

Table 3. Adjusted Odds Ratio with 95% CI of CHA type with gender.

Variables		**Odds Ratio**	**95% CI**		**p value**
			Lower limit	**Upper Limit**	
Gender	Male	3.1	1.165	8.249	0.023*
	Female	*Reference Category*			

The table no 3 shows the adjusted odds ratio (OR) for CHA type in relation to gender was calculated. Compared to females, males were found to have significantly greater odds of exhibiting CHA variations (OR = 3.1, 95% CI: 1.165–8.249, p = 0.023). Females were used as the reference category. This finding highlights a significant association between gender and CHA type.

Discussion:

Anomalies in the development of the abdominal aorta's blood vessels might lead to hepatic arterial abnormalities.

Sureka et al. investigated the origins of the common hepatic artery (CHA) in 600 patients through an analysis of vascular anatomy. According to the results, 575 individuals (95.83%) revealed CHA originating from the celiac axis, which is consistent with normal vascular anatomy. Despite some notable variations, the CHA originated from the superior mesenteric artery (SMA) in 6 cases (1%) and directly from the aorta in 2 cases (0.33%).Additionally, 4(0.66%) cases exhibited an ambiguous dual pathway involving a hepato-mesenteric trunk. Interestingly, in 13(2.16) cases, the origin of the CHA could not be determined[7].

Madhavi PS et al. employed Multi-Detector Computed Tomography (MDCT) to conduct a detailed assessment of the hepatic artery anatomy in 521 patients.Their findings showed that 393(75.4%) patients had a normal hepatic artery, while arterial variations were identified in 128(24.6%) patients. Among these variations, the common hepatic artery originated from the superior mesenteric artery (SMA) in 4 cases (0.7%) and from the aorta in 6 cases (1.2%) [8].

Rawat KS demonstrated that CT angiography can effectively assess vascular anatomy and identify the frequency of upper abdominal vascular variations in cancer patients.The study confirmed the high accuracy of CT angiography in delineating vascular structures and identifying anatomical variations. In a cohort of 125 patients, vascular variations were identified in 76(61%) cases, emphasizing the prevalence of such anomalies in this population. Variations in the origin of the CHA were observed in 4 patients (3%), with the artery arising from the aorta in 1 case (1%) and from the superior mesenteric artery (SMA) in 3 cases (2%) [9].

Farghadani et al. assessed the hepatic arterial anatomy of 607 patients using Multi-Detector Computed Tomography (MDCT). In their study, 16 patients (2.6%) exhibited variations in the origin of the common hepatic artery (CHA). Of these, 8 patients had the CHA arising from the superior mesenteric artery (SMA), while the other 8 had the CHA originating directly from the aorta[10].

In a large study of 5,002 cases, Song et al. used CT and digital subtraction angiography (DSA) to thoroughly examine morphological variations and normal vascular patterns. The investigation focused on the Common Hepatic Artery (CHA) in 4,939 patients, finding that 4,756 (96.30%) had a typical CHA structure. A rare variation was observed in 20 patients (0.40%), where the CHA originated directly from the aorta. Additionally, 148 patients (3.00%) had the CHA arising from the Superior Mesenteric Artery (SMA) [11].

The present study aligns with the findings of other studies, as the majority of patients in our analysis demonstrated a normal CHA anatomy, consistent with the dominance of the celiac axis as the primary origin (94.8%). In the present study, variations were observed with the common hepatic artery originating from the superior mesenteric artery in 1.2% of cases and from the aorta in 4.0% of cases.

Understanding these variations holds significant clinical relevance, particularly in surgical planning, interventional radiology, and liver transplantation procedures. Aberrant origins of the CHA, such as those observed in this study, can present challenges in identifying and preserving vascular structures, highlighting the need for careful preoperative imaging and individualized approaches to patient management. Furthermore, our findings highlight the significance of identifying and taking into consideration these variations in clinical practice and add to the expanding knowledge on hepatic vascular structure.

Conclusion: The studies reviewed collectively underscore the significant prevalence and clinical importance of hepatic arterial and abdominal vascular variations. While most people have normal vascular anatomy, a significant percentage have abnormalities, such as the common hepatic artery (CHA) originating from the superior mesenteric artery (SMA). These results highlight how important it is to have thorough preoperative imaging in order to precisely map vascular anatomy using sophisticated modalities like Multi-Detector Computed Tomography (MDCT) and CT angiography.

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Ethical Approval and Consent to participate

Applicable

Consent for publication

Not Applicable

Conflicts of Interest/Competing interests

The authors declare that they have no conflict of interest.

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