Journal of Cardiovascular Disease Research

ISSN: 0975-3583, 0976-2833 VOL 15, ISSUE 01, 2024

Original Research Article

STUDY OF ANATOMIC VARIANTS OF CELIAC TRUNK AND HEPATIC ARTERY IN CONTRAST ENHANCED COMPUTED TOMOGRAPHY SCAN OF ABDOMEN

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Received: 29-11-2023 / Revised: 04-12-2023 / Accepted: 02-01-2024

ABSTRACT

Background
This study was conducted to examine the anatomic variations of the hepatic artery and celiac trunk in an abdominal contrast-enhanced computed tomography image.

Methods
This was a hospital-based prospective observational descriptive study conducted among 300 patients undergoing triple phase contrast CT of the abdomen at Padmashree Dr. D.Y. Patil Medical College and Hospital and Research Centre, Pimpri Pune, over a period of six months from September 2020 to August 2022 after obtaining clearance from the institutional ethics committee and written informed consent from the study participants.

Results
The commonest level of origin of the celiac artery was at the lower border of T12 in 52.67% of individuals. The origin of the celiac artery was most commonly at the level of the median arcuate ligament (61.33%). The mean length of the celiac artery was 1.33 cm ± 0.43 cm (range: from 0.4 cm to 2.40 cm). The mean diameter of the celiac artery was 0.45 cm ± 0.15 cm (range: from 0.2 cm to 0.7 cm). Having three branches was the most common pattern of branching in the celiac artery. In 89% of cases, the right hepatic artery was shown to arise from the common hepatic artery; in 8% of cases, the hepatic artery had an aberrant origin;

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and in 5.16% of cases, the hepatic artery accessory was discovered. While 7% of the patients had an unusual origin, 86% of the patients had a left hepatic artery that came from the common hepatic artery. An auxiliary right hepatic artery was found in 5% of the cases. It was shown that the superior mesenteric artery was the auxiliary right hepatic artery's most common source. Research revealed that the left gastric artery was the most common source of auxiliary left hepatic arteries. It was demonstrated that the superior mesenteric artery was the most common source of an aberrant right hepatic artery. Research revealed that the left gastric artery was the most common source of an aberrant left hepatic artery.

Conclusion

It is imperative to consider differences in the hepatic and celiac arteries during transplantation, interventional treatments, and surgical resection. Prior to these operations, being aware of CT variance helps lower the risk of surgical problems. Before undergoing surgical and interventional radiology procedures, these variances should be accurately stated in the radiological report.

Keywords: Anatomic Variants, Celiac Trunk, Hepatic Artery, Contrast, Enhanced, Computed Tomography, Abdomen.

INTRODUCTION

The celiac artery is the first ventral branch, which arises from the abdominal aorta. The celiac trunk or celiac axis are other names for it. It arises from the aorta at T12-L1 vertebral level, directly beneath the diaphragm's aortic hiatus, and measures only 1.25 centimeters in length.[1] A trifurcation is the most prevalent type of classical branching pattern for the celiac trunk, and Haller first identified one in 1756 under the name Tripus Halleri. The left gastric artery, common hepatic artery, and splenic artery are the three main branches in a typical branching pattern. The organs that come from the foregut receive blood and nourishment from the celiac artery and its branches. The stomach, spleen, pancreas, liver, and part of the duodenum are among these organs.[2] In 1756, Haller provided the first description of normal and abnormal celiac trunk anatomy. It would appear that Lipshutz was the first person to propose categorizing celiac disease into one of four different types of trunks. Later on, Adachi provided a categorization that was more in-depth, while Morita and Michels were the ones who came up with the two classifications that are currently the most widely used. Knowing the variant vascular anatomy of the upper digestive tract will help hepato-biliary surgeons reduce the danger of unexpected bleeding during operations and raise the likelihood that they will accomplish R0 resection during liver or pancreaticoduodenectomy surgeries.[2] If the right, left, and middle hepatic arteries can feed the right, left, and quadrate lobes of the liver, respectively, after branching out of the celiac trunk, then it is considered normal or usual. An "aberrant" liver artery can be either an auxiliary or a replacement, and it is defined as one that does not stem from the traditional celiacal hepatic artery. There are two types of anomalous hepatic arteries. The term "accessory" hepatic arteries should only be used to characterise circumstances in which an extra artery from a different source is present in addition to the normal right or left hepatic artery (derived from the celiac artery). In other words, there was no other context in which the phrase "accessory" hepatics could be applied. In the event that the normal right or left hepatic artery, which emerges from the celiac artery, is absent, a blood vessel known as a "replaced" right or left hepatic artery grows from another

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source to supply the right or left lobe. This name is used because the vessel might serve the left or right lobe.[3] The frequency of various celiac and hepatic artery anomalies was calculated using Uflacker's and Michel's classifications. Between 22 and 48 percent of individuals had celiaco-mesenteric arterial aberrations, according to Michels' research on anatomical vascular anomalies. Numerous studies have been conducted since Michels' first publication, and these studies have not only shown common and uncommon variations of the hepatic artery but also different classifications of these variations.[4]

AIMS AND OBJECTIVES

- To examine the anatomic variations of the hepatic artery and celiac trunk using abdominal contrast-enhanced computed tomography imaging.
- To study the anatomy of the celiac trunk with respect to its level of origin, length, and diameter.
- To study the spectrum and prevalence of variations in the branching pattern of celiac trunk.
- To study the spectrum and prevalence of variations in hepatic artery.

MATERIALS & METHODS

This was a hospital-based prospective observational descriptive study conducted among 300 patients undergoing triple phase contrast CT of the abdomen at Padmashree Dr. D.Y. Patil Medical College and Hospital and Research Centre, Pimpri Pune, over a period of six months from September 2020 to August 2022 after obtaining clearance from the institutional ethics committee and written informed consent from the study participants.

Inclusion Criteria

Adults, both male and female, having an abdominal triple-phase contrast CT scan.

Exclusion Criteria

- Pediatric patients
- Individuals who have had upper abdomen surgery may experience disruptions in vascular architecture.
- Abdominal diseases obstructing the view of the abdominal arteries;
- All patients not appropriate for CT scanning;
- Patients contraindicated receiving a Contrast injection.

Statistical Methods

Data was entered in MS Excel and analyzed using SPSS software. The results were presented as tables.

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RESULTS

Level of Origin of Celiac Artery	Frequency	Percentages
At T12-L1 disc	25	8.33%
Lower Border of T12*	158	52.67%
Lower border L1	39	13.00%
Upper Border of L1	38	12.67%
Upper Border of T12	40	13.33%
Total	300	100%
Analysis of Level of Origin of Celiac Artery in the Study Population (N=300)		
Relation to Median Arcuate Ligament	**Frequency**	**Percentages**
Above the Level	29	9.67%
At the level*	184	61.33%
Below the level	87	29.00%
Total	300	100%
Analysis of Relation of Celiac Artery to Median Arcuate Ligament in the Study Population (N=300)		
(* - one of the individuals had common origin of celiac artery and superior mesenteric artery – i.e. celiaco-mesenteric trunk.)		
Table 1		

Among the 300 participants in the study, 158 (52.67%) had the lower border of T12, 25 (8.33%) had the origin of the celiac artery at T12-L1 disc level, 40 (13.33%) had the upper border of T12, 38 (12.67%) had the upper border of L1 and 39 (13%) had the lower border of L1.

With respect to the median arcuate ligament, 184 (61.33%) of the 300 participants in the study were at the level of the ligament, 87 (29.00%) were below the level of the ligament, and 29 (9.67%) were above the level of the ligament.

Parameter	Mean ± SD	Median	Minimum	Maximum
Length (Cm)	1.33 ± 0.43	1.30	0.40	2.40
Diameter (Cm)	0.45 ± 0.15	0.46	0.20	0.70
Analysis of Length, Diameter of Celiac Artery in Study Population (N=300)				
No. of Branches		**Frequency**	**Percentages**	
2.0		34	11.33%	
3.0		242	80.00%	
4.0		8	2.66%	
5.0		16	5.33%	
Total		300	100%	
Analysis of Number of Branches of Celiac Artery in the Study Population (N=300)				
Table 2				

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The average length of the celiac artery in 300 participants in the study was 1.33 cm ± 0.43 cm. The average diameter was 0.45 cm ± 0.15 cm, with a minimum diameter of 0.46 cm and a maximum diameter of 0.70 cm.

In the 300 participants in the study, 242 individuals (80%) had three branches of the celiac artery. 34 (11.3%) individuals had two branches of the celiac artery, with one of the branches having an extra-celiac origin. 8 (2.6%) individuals had 4 branches of the celiac artery, while 16 (5.3%) individuals had 5 branches.

Out of 34 (11.3%) individuals who had two branches of the celiac artery:

- 10 (3.33%) individuals had an extra celiac origin of the left gastric artery (in all 10 cases, the left gastric artery was arising directly from the aorta).
- 9 (3%) individuals had an extra celiac origin of the common hepatic artery; in 5 (1.66%) of them, the common hepatic artery was arising from the superior mesenteric artery, while in 4 (1.33%) cases, it was arising from the aorta.
- 15 (5%) individuals had an extra celiac origin of the splenic artery; in 11 (3.66%) cases, the splenic artery was arising from the aorta, while in 4 (1.33%) cases, it was arising from the superior mesenteric artery.

Out of 24 (8%) individuals who had more than 3 branches of the celiac artery:

- 16 (5.33%) individuals had a left inferior phrenic artery arising from the celiac artery.
- 24 (8%) individuals had a right inferior phrenic artery arising from the celiac artery.
- 3 (1%) individuals had a dorsal pancreatic artery arising from the celiac artery.

A single person possessed a shared ancestor for both the celiac and superior mesenteric arteries, often known as the celiaco-mesenteric trunk. The common trunk was around 2.3 cm in length and 1 cm in diameter. The celiac branch's diameter was 0.7 cm, and its approximate length measured 0.9 cm. The left gastric artery of the same patient originated directly from the aorta.

Out of the people in the research, 267 (89.00%) had a fully developed right hepatic artery, meaning they had neither an aberrant nor an auxiliary hepatic artery. Nine (3%) people had an auxiliary right hepatic artery, and 24 (8%) had an abnormal right hepatic artery.

Of the patients in the research, 260 (86.00%) had a normal course of the left hepatic artery, meaning they had neither an aberrant nor an auxiliary hepatic artery. Thirteen (4.3%) people had an auxiliary left hepatic artery, whereas 27 (9.7%) people had an aberrant left hepatic artery.

Nine people (3%) had an auxiliary right hepatic artery; six people (2%) thought it originated from the superior mesenteric artery, and three people (1%) thought it originated straight from the celiac artery.

The left gastric artery was the source of the auxiliary left hepatic artery in 10 (3.33%) of the cases.

Of the study population, 24 individuals (8%) had a right hepatic artery anomalous origin. The superior mesenteric artery (9 people, or 3%), the gastroduodenal artery (6 people, or 2%), the celiac artery (4 people, or 1.33%), and the aorta (3 people, or 1%), were the most frequent sources of an aberrant right hepatic artery. Two people (0.66%) each had a right hepatic artery that originated from the splenic and left gastric arteries.

Of the study population, 27 individuals (about 9%) had a left hepatic artery

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anomalous origin. The left gastric artery (12 cases, or 4%), the superior mesenteric artery (3 cases, or 1%), the aorta (5 cases, or 1.66%), and the celiac artery (7 cases, or 2.33%) were the most frequent sources of an aberrant left hepatic artery.

DISCUSSION

Our study aims to understand the anatomic variants of the celiac artery and hepatic artery CECT of the abdomen. The study was conducted on 300 randomly selected individuals in the Radiology Department of Dr. D. Y. Patil Medical College, Hospital and Research Center. The mean age of the study population was 41.08 (± 12.36) years, with the range being 20 to 60 years. Out of 300 individuals, 153 were males and 147 were females.

The hepatic and celiac arteries' anatomical variances are essential for abdominal radiological procedures as well as surgery, including liver transplant surgery. Because of these differences, there is a greater chance of vascular damage, which can lead to serious ischemia of the liver, problems draining a liver abscess, biliary fistula, or bleeding. As a result, precise identification of variable vascular architecture can raise surgical success rates and lower the incidence of problems following surgery.[5]

Origin of Celiac Artery (With Respect to Vertebral Level and Level of Median Arcuate Ligament)

The study done by Sehgal G et al. [6] found the origin of the celiac artery most commonly at T12-L1 disc level, followed by the upper border of the T12 vertebrae, and then the lower border of the L1 vertebrae.

In our study, we found the origin of the celiac artery most commonly at the lower border of T12, followed by the upper border of T12 vertebrae, and then the lower border of L1 vertebrae.

In a study by Sehgal G et al., the level of origin of the celiac artery was most commonly at the level of the median arcuate ligament, followed by below and above the level of the ligament. We found similar results in our study.

We discovered one instance where the aorta was the common origin of the celiac artery and the superior mesenteric artery, or celiaco-mesenteric trunk (0.33%). According to Wang et al., 3.4% of cases of celiaco-mesenteric trunk occur.

Dimensions of Celiac Artery (Length and Diameter)

In the study done by Sehgal G et al., the mean length of the celiac artery was 1.75 cm ± 0.50 cm, with a range of 1.5 cm to 2 cm. In our study, the mean length of the celiac artery was 1.33 cm ± 0.43 cm, with a wider range than Michels et al. (range in our study: 0.4 cm to 2.40 cm).

In the study done by Best, Yan Y et al.[7] the mean diameter of the celiac artery was 0.78 cm, with the range being 0.30 cm to 0.90 cm. In our study, the mean diameter of the celiac artery was 0.45 cm, with the range being 0.20 cm to 0.70 cm.

Branching of Celiac Artery

In the study done by Iezzi R et al.[8] they found 3 branches of the celiac artery (the most common) in 85% of the individuals, followed by 2 branches in 8.4% of the individuals, 5 branches in 4% of the individuals and 4 branches in 2.6% of the individuals (least common).

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In our study, we found 3 branches of the celiac artery (the most common) in 80% of the individuals, followed by 2 branches in 11.3% of individuals, 5 branches in 5.33% of individuals and 4 branches in 2.66% of individuals (the least common).

Iezzi R et al. found in their study the aberrant origin of the left gastric artery directly from the aorta in 4.4% of individuals, while in our study the incidence was 3.3%.

The incidence of right and left inferior phrenic arteries arsing from the celiac artery was found to be 6% and 5%, respectively, in the study by Iezzi R et al., while the respective figures were 8% and 5.33% in our study.

Hepatic Arteries

According to Satheesha Nayak, Sureka, et al. research,[9] 89.34% of participants had a right hepatic artery that originated from a common hepatic artery, whereas 5.5% had an abnormal origin. In 5.16% of cases, an accessory right hepatic artery was discovered. In the Michels et al. research,[10] corresponding numbers were 88%, 7%, and 5%. A similar incidence was also seen in our study, with equivalent values of 89%, 8%, and 3%.

According to a study by Sureka et al., 88% of participants had left hepatic artery origins from common hepatic artery origins, whereas 7% had aberrant origins. In 5% of cases, an accessory left hepatic artery was discovered. In the Michels et al. investigation, the corresponding percentages were 84%, 9%, and 7%. A similar incidence was also seen in our study, with equivalent values of 86%, 9.7%, and 4.3%.

In the study by Sureka et al., the origin of the auxiliary right hepatic artery was determined to be the superior mesenteric artery in 5.16% of the persons and the celiac artery in 2.5% of the individuals; the comparable percentages in our investigation were 2% and 1%, respectively. We observed a lesser incidence of accessory right hepatic artery compared to the study by Sureka et al. The left gastric artery was found to be the source of origin of the accessory left hepatic artery in the study by Sureka et al. as well as in our study, with an incidence of 7% and 3.33%, respectively. Similar to accessory right hepatic artery, we found a lesser incidence of accessory left hepatic artery compared to the study by Sureka et al.

According to a research by Sureka et al., the aorta (0.11%), gastroduodenal artery (2.5%), celiac artery (1.8%), and superior mesenteric artery (10%) were the most prevalent sources of origin of an aberrant right hepatic artery. Furthermore, our research showed that the superior mesenteric and gastroduodenal arteries caused 3% of all aberrant right hepatic arteries. These were followed by the aorta at 1% and the celiac artery at 1.33 %.

Compared to Sureka et al., a lesser incidence of superior mesenteric artery as a source of origin of aberrant right hepatic artery (3% vs. 10%) and a greater incidence of aorta as a source of origin of aberrant right hepatic artery (1% vs. 0.11%) were noted in our study.

According to a research by Sureka et al., the aorta (5%), celiac artery (7%), and left gastric artery (10%) were the most prevalent origins of aberrant left hepatic arteries. The left gastric artery (4%), aorta (1.66%), and celiac artery (2.33%) were the three most frequent sources of aberrant left hepatic arteries in our analysis. Compared to Sureka et al., a lesser incidence of aberrant left hepatic artery was noted in our study; however, the descending order of frequency of the source of origin of the aberrant left hepatic artery remained the same.

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CONCLUSION

During surgical resection, interventional therapies, and transplantation, it is important to consider differences in the hepatic and celiac arteries. Prior to these operations, being aware of CT variance helps lower the risk of surgical problems. Before undergoing surgical and interventional radiology procedures, these variances should be accurately stated in the radiological report.

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