Original Article

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Radiology Section

Variants of Coeliac Trunk, Hepatic Artery and Renal Arteries in Puducherry Population

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ABSTRACT

Introduction: In the modern era of surgery where we have increased number of hepatic, biliary, pancreatic and renal surgeries we should be aware of the variations in anatomy of coeliac axis, hepatic arteries and renal arteries to prevent injuries and ischaemic complications that can happen at the time of surgery.

Aim: To study the normal anatomy and variations in the anatomy of coeliac axis, hepatic arteries and renal arteries with the help of CT angiography which could help hepatobiliary surgeons, renal surgeons and interventional radiologists at the time of surgery.

Materials and Methods: A retrospective study was performed in which CT images of 200 patients who had undergone CECT of abdomen for various causes in our institute in last one year were studied. The coeliac axis, hepatic arteries and renal arteries were individually evaluated for anatomical variations. Data was entered into Microsoft Excel data sheet and was analysed using SPSS 22.0 version software. Data was represented in the form of percentage.

Results: There was normal anatomy of coeliac axis seen in 181 patients (90.5%) and 19 (9.5%) patients showed coeliac axis variations. Hepatic artery normal anatomy was seen in 153 patients (76.5%) and 47 patients (23.5%) showed variations in hepatic arterial anatomy. Normal renal arterial anatomy i.e., one renal artery on each side was seen in 158 patients (79%) and 42 patients (21%) showed variation in renal arterial anatomy.

Conclusion: It is common to see the variations in coeliac axis, hepatic arteries and renal arteries in day to day practice the thorough knowledge of which is necessary. With the use of MDCT these variations can be easily seen and understood.

Keywords: Abdominal aorta branches, Anatomical variations, Hiatt's classification, Michel's classification, Uflacker's Classification

INTRODUCTION

In the modern era of imaging and interventions and with advancement and increase in hepatic and pancreatic surgeries, hepatic transplants, renal transplants, laparoscopic operations and radiological interventions there is an utmost importance of knowing the variations in hepatic artery, coeliac axis and renal arteries to avoid iatrogenic injuries to the vessels during the operation. The variations in the anatomy of the coeliac axis and hepatic artery carry a significant importance in procedures such as transplant of liver, laparoscopic surgery, abdominal radiological interventions and surgical treatment of abdominal injuries [1,2].

Identification of renal artery variations holds considerable importance in renal transplantation surgeries, surgical or interventional radiological treatment of reno-vascular hypertension and nephrectomy [3].

Although, the gold standard procedure for evaluating vascular structures is Digital Subtraction Angiography (DSA), due to its invasive nature it has limited role. Now a days Multidetector CT (MDCT) is used in place of DSA for evaluation of vascular structures due to its less invasive nature and and excellent image quality.

The study is aimed towards the examination of anatomical variations of coeliac trunk, hepatic arterial system and renal arteries along with their prevalence. For this purpose we examined the vascular systems of patients in whom CT angiography of abdominal aorta was done for any reason.

MATERIALS AND METHODS

In this study a retrospective analysis of 200 patients, who have undergone CECT abdomen in last one year (June 2016 to June 2107) was done. This study was conducted in the Department of Radiology at Sri Manakula Vinayagar Medical College and Hospital, Puducherry, India. Patients of all the

ages and both the sexes are included in the study. Patients who have gone through major abdominal surgeries or having hepatic artery, coeliac axis or renal artery occlusion are excluded from the study.

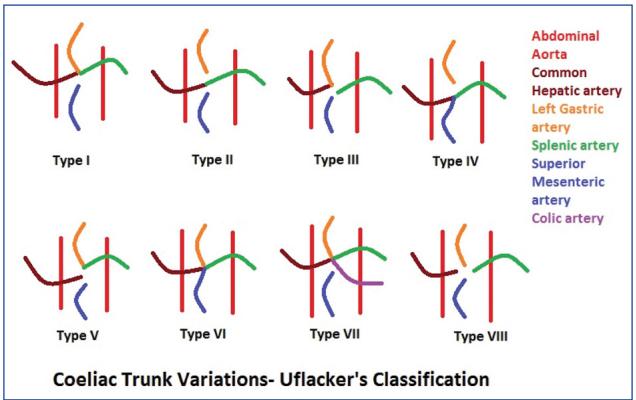
Imaging Technique

The scans were done using Philips 16-slice MDCT at 120 KVp and 300 mAs with 5 mm slice thickness, 0.8 second gantry rotation. 3-5 mL/kg body weight (100-150 mL) iodinated contrast (iohexol) with iodine concentration of 350 mg/mL was injected and arterial phase images were obtained which were reconstructed with 0.625 mm slice thickness and reformatted in sagittal and coronal planes and Maximum Intensity Projection (MIP) images for analysis. The clearance for study was obtained from research and ethical committee of the institution and being a retrospective study the informed consent was not taken.

Vascular System Analysis

The coeliac axis, hepatic artery and renal arterial anatomy was analysed using axial, coronal, sagittal, MIP and 3D volume rendered images.

Each arterial system was individually analysed using Uflacker's



[Table/Fig-1]: Diagrammatic representation of coeliac trunk variations according to Uflacker's classification.

Coeliac trunk variation	Uflacker's classification	No. of patients
Classic coeliac trunk	Type I	181
Hepatosplenic trunk	Type II	2
Hepatogastric trunk	Type III	0
Hepato-splenic mesenteric trunk	Type IV	5
Gastrosplenic trunk	Type V	3
Coeliac-mesenteric trunk	Type VI	9
Coeliac-colic trunk	Type VII	0
No coeliac trunk	Type VIII	0
Total		200

[Table/Fig-2]: Coeliac trunk variations: Uflacker's classification [4].

Hepatic Artery variation	Michel's classification	Hiatt's classification	No. of patients
Normal anatomy	Type I	Type I	153
Replaced Left Hepatic Artery (LHA) originating from the Left Gastric Artery (LGA)	Type II	Type II	10
Replaced Right Hepatic Artery (RHA) originating from the Superior Mesenteric Artery (SMA)	Type III	Type III	18
Co-existence of Type II and III	Type IV	Type IV	5
Accessory left hepatic artery originating from the left gastric artery	Type V	Type II	11
Accessory right hepatic artery originating from the superior mesenteric artery	Type VI	Type III	3
Accessory left hepatic artery originating from the left gastric artery and accessory right hepatic artery originating from the superior mesenteric artery	Type VII	Type IV	0
Accessory left hepatic artery originating from the left gastric artery and replaced right hepatic artery originating from the superior mesenteric artery	Type VIII	Type IV	0
Common hepatic artery originating from the superior mesenteric artery	Type IX	Type V	0
Right and left hepatic arteries originating from the left gastric artery	Type X	NOD	0
Common hepatic artery directly originating from the aorta	NOD	Type VI	0

[Table/Fig-3]: Hepatic artery variations: Michel's and Hiatt's classifications [6,7].

classification system [Table/Fig-1,2] for coeliac axis [4] and Michel's classification along with Hiatt's classification [Table/Fig-3] system for hepatic artery [5].

Michel's classification of the hepatic arterial system described 10 variant subtypes [6]. The accessory and replaced hepatic arterial systems were described separately within this classification. Under Hiatt's classification, this distinction was not made because of the difficulty to distinguish between accessories and replaced hepatic arterial structures angiographically, and so six subtypes were described [7].

The renal arteries were assessed with respect to their origin, number of arteries and laterality.

Coeliac Axis (CA): Branching pattern of coeliac axis have been read by various authors [5,8-13]. It is a major visceral branch of the abdominal aorta originating at its anterior contour just below the aortic hiatus of diaphragm at the level of T12- L1 vertebral bodies. It is about 1.5-2 cm long and 6-8 mm in diameter. It passes almost horizontally forward and divides into three branches-left gastric, splenic and common hepatic arteries [14,15].

Common Hepatic Artery (CHA): Defined as the arterial trunk containing at least one branch of the hepatic artery and the gastroduodenal artery.

In case where the origin of right hepatic artery is not from common hepatic artery or proper hepatic artery it originates from either aorta or from an artery that courses normally on the right side of aorta e.g., SMA [16,17].

Renal Artery (RA): Usually, each kidney is supplied by one renal artery which directly arises from the abdominal aorta on the ipsilateral side for each kidney. Any change in origin of vessels from the above mentioned definitions is considered as a variation.

Due to the ascent from the pelvis the blood supply of kidneys keeps changing and so we see a wide variety of variations in renal arteries [3,18].

Kidneys with single renal artery show less post surgical kidney loss and complications when transplanted as compared to kidneys with multiple renal arteries [3,19].

Therefore, it is important to identify variations of renal arteries before any renal transplant surgery, interventional treatment of kidney disease and surgical nephrectomy [3].

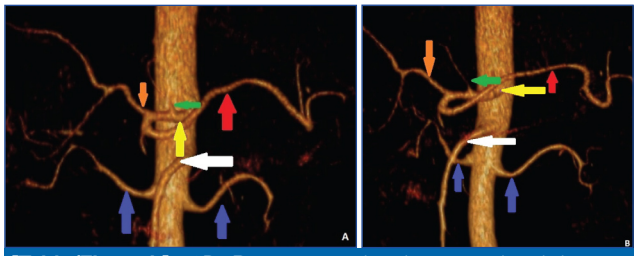
STATISTICAL ANALYSIS

Data was entered into Microsoft excel datasheet and was analysed using SPSS 22.0 version software. Data was represented in the form of percentage.

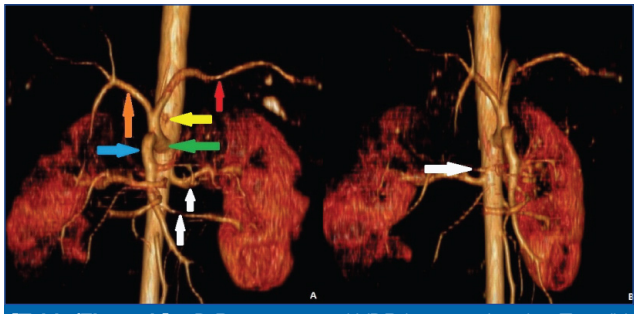
RESULT

Contrast CT images of 200 patients were retrospectively studied who underwent CECT abdomen for various reasons at out hospital in last one year and were not under our exclusion criteria, this included both male and female patients. The study includes patients between 15-70 years of age with 110 males and 90 females.

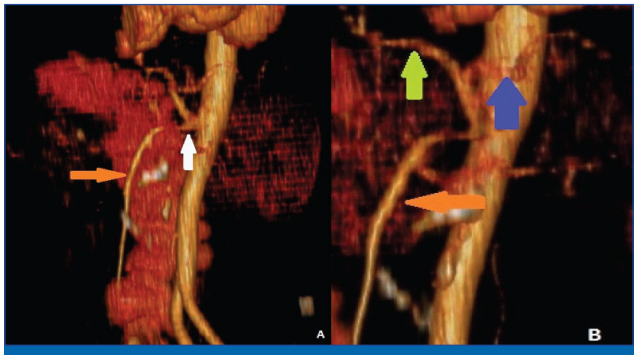
Coeliac trunk variations: According to Uflacker's classification, out of a total of 200 patients 181 patients (90.5%) showed Type I anatomy [Table/Fig-4], 2 patients (1%) showed Type II variation, 5 patients (2.5%) showed Type IV variation [Table/Fig-5], 3 patients (1.5%) showed Type V variation and 9 patients (4.5%) showed Type VI variation [Table/Fig-6]. None of the patients in our study showed Type III, Type VII and Type VIII variations. Out of 110 males 98 (89%) showed normal anatomy i.e., Type I while 12 (11%) showed variations. Out of 90 females 83 (92%) showed normal anatomy i.e., Type I and 7 (8%) showed variations.



[Table/Fig-4a,b]: 3D Reconstructed volume rendered images showing normal anatomy and origin of CT (yellow arrow) and its branches i.e., CHA (orange arrow), LGA (green arrow), and splenic artery (red arrow), SMA (white arrow).

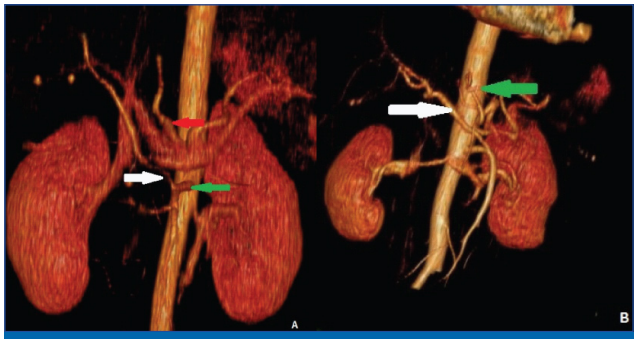


[Table/Fig-5a,b]: 3D Reconstructed VDR images showing Type IV coeliac trunk (green arrow), splenic artery (red arrow), CHA (orange arrow), SMA (blue arrow), separate origin of LGA (yellow arrow), two renal arteries on both right and left side (white arrows).

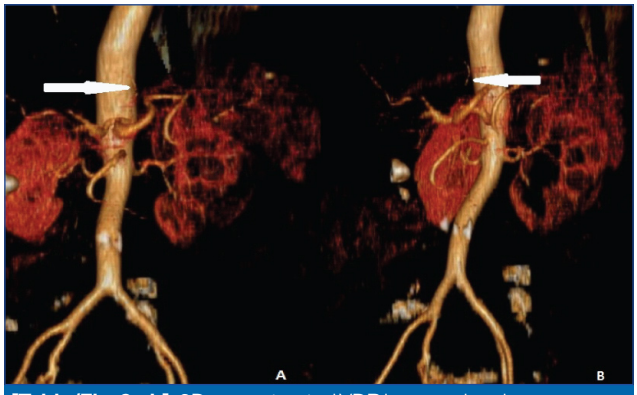


[Table/Fig-6a,b]: 3D reconstructed VDR images showing Type VI coeliac trunk.common origin of coeliac trunk and SMA (white arrow), SMA (yellow arrow), splenic artery (blue arrow), CHA (green arrow).

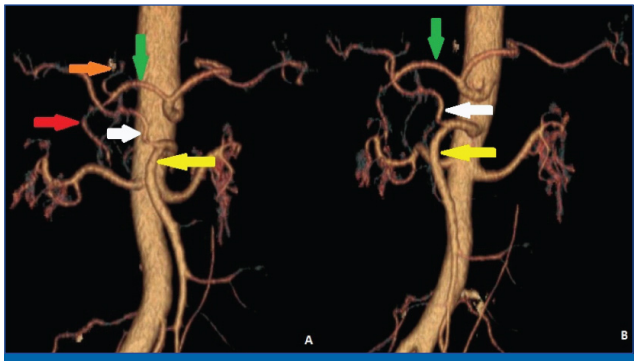
Hepatic artery variations: According to Michel's classification, Out of total 200 patients 153 (76.5%) showed normal i.e., Type I anatomy, 10 patients (5%) showed Type II variation, 18 patients (9%) showed Type III variation, 5 patients (2.5%) showed Type IV variation [Table/Fig-7], 11 patients (5.5%) showed Type V [Table/Fig-8] variation, and 3 patient (1.5%) showed Type VI variation [Table/Fig-9]. None of the patients showed Type VII, VIII, IX and X variations.



[Table/Fig-7a,b]: 3D reconstructed VDR images. a) showing replaced RHA (white arrow) originating from SMA (green arrow) and CHA continuing as LGA (red arrow); b) showing replaced RHA (white arrow) originating from SMA and replaced lha (green arrow) originating from LGA.



[Table/Fig-8a,b]: 3D reconstructed VDR images showing accessory LHA (white arrows) originating from LGA.



[Table/Fig-9a,b]: 3D reconstructed VDR images showing accessory right hepatic artery (white arrow) originating from SMA (yellow arrow), CHA (green arrow), right (red arrow) and left (orange arrow) hepatic arteries.

According to Hiatt's classification, out of total 200 patients, 153 patients (76.5%) showed normal i.e., Type I anatomy, 21 patients (10.5%) showed Type II variation [Table/Fig-8], 21 patients (10.5%) showed Type III variation [Table/Fig-9] and 5 patients (2.5%) showed Type IV variation [Table/Fig-7]. None of the patients showed Type V and VI variations.

Out of total 110 male patients 89 (81%) showed normal i.e., Type I anatomy and 21 (19%) showed variations. Out of total 90 female patients 64 (71%) showed normal anatomy and 26 (29%) showed variations.

Renal artery variations: Out of total 200 patients, 158 patients (79%) showed normal anatomy i.e., one renal artery on each side, 15 patients (7.5%) showed two renal arteries on right side [Table/Fig-10], 21 patients (10.5%) showed two renal arteries on left side [Table/Fig-11] and 6 patients (3%) showed two renal arteries on both right and left side [Table/Fig-12]. Out of 110 male patients 89 (81%) showed normal anatomy and 21 patients (19%) showed variations. Out of 90 female patients 70 patients (78%) showed normal anatomy and 20 patients (22%) showed variations.

There was only one patient which showed renal artery variation along with hepatic artery variation [Table/Fig-13] and one patient showed coeliac axis variation along with hepatic artery variation.

[Table/Fig-10a,b]: 3D reconstructed volume rendered images showing two renal arteries (white arrows) on right side as seen from lateral and posterior aspect.

[Table/Fig-11]: 3D reconstructed volume rendered image showing two renal arteries (white arrow) on left side when seen from posterior aspect.

Renal Artery Variation	No. of Patients
One renal artery on each side	158
Two renal arteries on left	21
Two renal arteries on right	15
Two renal arteries on each side	6
Total	200

[Table/Fig-12]: Renal artery variations.

[Table/Fig-13a,b]: 3D reconstructed VDR images showing replaced right hepatic artery (white arrow) originating from SMA (orange arrow), and two renal arteries on left side (blue arrows).

DISCUSSION

The gastrointestinal system receives its blood supply from three vessels arising at three different levels in abdominal aorta. There may be variations in these vessels due to differences during embryonic development [20].

The study of renal artery variations is also important as it creates problems for surgeons. There is a reported higher chance of renal transplant failure in patients with multiple renal arteries [21].

Coeliac trunk with normal trifurcation have a frequency of 72-90% in the normal population as per previous studies [22] Vandamme and Bonte studied one of the largest series [23], and found normal coeliac trifurcation in 86%. In this study we found that out of total 200 patients 181 patients (90.5%) showed normal anatomy of coeliac axis i.e., Type I, and the remaining 19 patients (9.5%) showed variations among which the most common variation of coeliac axis in this study was Type VI and was seen in 9 (4.5%) patients. In the study by Song SY et al., on 5002 patients they noted normal CA in 89.1% and other Types of CA variation identified in 9.4% of the people. In the remaining 1.26%, the CA anatomy could not be defined as CHA was absent due to separate origin of the hepatic arteries [24]. In a similar study by Sureka B et al., on 600 patients, they found out six Types of celiac axis anatomic variations and 91% of the patients had normal celiac axis anatomy [25].

Among hepatic artery variations in our study we found 153 patients (76.5%) showed normal i.e., Type I anatomy and rest 47 patients (23.5%) showed variations. In studies by Chen CY et al., and Kamel IR et al., using digital subtraction angiography a normal hepatic artery anatomy was seen in 68% and 70% of patients respectively [26,27].

Although, DSA is considered as a gold standard procedure in evaluation of vascular structures but due to its high invasive nature its role is limited. In the modern world of MDCT the vascular anatomy can be easily studied along with the small vessels. MDCT being quick and non-invasive has overcome the use of DSA [5]. Moreover, CT provides higher contrast resolution and its ability to reconstruct images in several planes further helps in studying the course of vessels accurately.

LIMITATION

Since, the total number of patients included in the study was relatively small, some of the rare variations in coeliac/hepatic artery were not observed in the study. A larger study over a longer period of time would be recommended.

CONCLUSION

In this study we infer that variations in coeliac axis, hepatic arteries and renal arteries are common in day to day practice. Therefore, thorough knowledge of these disparities is necessary to avoid complications and injuries during the surgical procedures and radiological interventions. With the use of MDCT these variations can be easily seen and understood, therefore must be assessed in each case preoperatively.

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