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Multidetector Computed Tomography (MDCT) Evaluation of Anomalies of Abdominal Aorta & Its Major Branches.

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ABSTRACT

Background: With the advent of multidetector computed tomography (MDCT) especially 64-slice & 128-slice scanners, it is possible to acquire high-resolution data with very high-speed. Therefore, it is now possible to recognise incidental anomalies of abdominal aorta & its major branches with relative ease during routine contrast-enhanced computed tomography abdominal examinations. Great variability in abdominal vasculature also makes the incidental detection extremely important & helpful in laparoscopic surgeries, colonic resections, and various interventional radiological procedures in abdominal region. Radiologists should therefore recognise and describe the unsuspected anomalies for future reference or predicting prognosis. Hence, this prospective pilot study evaluates the role of routine MDCT abdomen in evaluation of anomalies of abdominal aorta and its major branches. **Methods:** Two-hundred CECT abdomen including single, dual & triple phase scans were included in the study where the intravenous contrast was administered through pressure injector and findings were recorded in maximum intensity projection (MIP) & 3D-volume rendered images. **Results:** Out of 200 patients included in the study, less than 50% had classical branching pattern showing high incidence of variation. Maximum variations were recorded in renal arteries (86 of 200) followed by celiac artery (42 of 200). No variation was however recorded in inferior mesenteric artery in our study. **Conclusions:** Variations in abdominal vasculature has a high incidence making it imperative to record them whenever the optimal CECT abdominal scans are obtained for any indication. This information might be very useful while performing interventional procedures and minimally invasive surgical procedures that may be robotic assisted.

Keywords: Multidetector, computed tomography, anomalies, aorta.

INTRODUCTION

Abdominal aorta is the continuation of thoracic descending aorta, extending from the 12th dorsal vertebra (level of aortic hiatus) to L4 vertebral level, where it bifurcates into right & left common iliac arteries. Branches of abdominal aorta may be classified as ventral, lateral and dorsal, on the basis of their origins. The celiac trunk, superior & inferior mesenteric arteries arises from the ventral; lumbar & median sacral arteries from dorsal and inferior phrenic, middle suprarenal, renal & ovarian / testicular arteries arise from lateral aspect of abdominal aorta [Figure 1].[1]

Evaluation of these branches arising from the abdominal aorta with respect to their level of origin, presence of any variations in the pattern of their origin, presence of any additional artery and variations in their second order branching is of immense value for an interventional radiologist for precise planning before a diagnostic as well as therapeutic imaging procedures like percutaneous angiography, angioplasty & stenting, coiling, transjugular intrahepatic portosystemic shunt (TIPS), transcatheter arterial chemoembolisation (TACE), etc. It also plays an important role for a surgeon in preoperative planning of various laparoscopic & robotic-assisted surgeries, organ transplantations, and in oncologic resections in abdominal region.[2,3]

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With the advent of Multi-detector computed tomography (MDCT) scanners especially 64-slice & above, it is now possible to acquire high-resolution data with very high-speed which can be post-processed to obtain maximum intensity projections (MIP) and volume rendered (VR) reconstructions. Therefore, it is now possible to incidentally recognize anomalies of abdominal aorta & its major branches with relative ease during routine contrast-enhanced computed tomography (CECT) abdominal examinations obviating the need for dedicated angiography except in cases where prior examinations are not available. Also, the incidentally-detected anomalies may be useful

during emergency procedures where lack of time or deranged renal function might deter the dedicated angiographic examination.
Hence, the aim of our study was to evaluate the role of MDCT in determining anomalies of abdominal aorta & is major branches during routine CECT abdominal examinations done for indications other than congenital causes; to determine the incidence of anomalies of abdominal aorta & its branches in our region and to compare these results with those present in the existing medical literature.

MATERIALS & METHODS

The study was done on 200 patients who underwent routine CECT abdominal examinations on 128-slice CT scanner (PHILIPS Ingenuity) in our department. The scan area extended from the domes of diaphragm to lower border of pubic symphysis. CECT examination included single, dual and triple phase scans with slice thickness of 2 mm, interslice gap of 1 mm and gantry rotation time of 0.5 seconds. Vascular access was obtained with 18G or a 20G intravenous cannula inserted into the antecubital vein. The volume of the non-ionic iodinated contrast agent (300mg iodine / ml) used ranged from 25-30 ml for children and 50 to 60 ml in adults, depending on the patient's body weight. The rate of contrast agent injection was 3.0-4.0 ml/sec. Contrast agent bolus was administrated using an automatic syringe followed by saline chase.
Multiplanar, maximum intensity projections and 3D VRT images were used to record the findings. The data thus obtained was analysed to calculate the occurrence of different anomalies of abdominal aorta.

RESULTS

Out of 200 patients included in study, 94 were males & 106 were females. The minimum age of patient included in study was one year and the maximum was 80 years. The maximum number of patients was in age group of 21-40 years (84 patients).
Out of 200 CECT examinations, 38 patients underwent triple phase, 124 underwent dual phase and 38 underwent single phase scan.
In our study, only 90 patients (45%) revealed typical branching of abdominal aorta while rest 110 patients (55%) revealed one or other forms of variation [Table 1].

Table 1: Showing prevalence of anomalies among major branches of abdominal aorta.

Artery	No. of patients	Normal	Variations
Celiac artery	200	158	42
SMA	200	186	14
IMA	200	200	0
Renal arteries	200	114	86

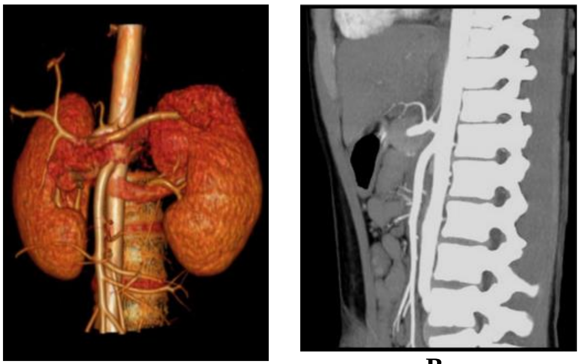
A B

Figure 1: VRT CT images in coronal (A) and sagittal plane showing normal anatomy of Abdominal Aorta & its major branches.

Figure 2: VRT CT image in oblique sagittal plane showing hepatic artery proper arising from SMA.

A B

Figure 3: Sagittal VRT (A) and MIP (B) CT images show common origin of celiac trunk & SMA.



A B

Figure 4: Coronal VRT (A) and Sagittal MIP (B) CT images show inferior phrenic artery arising from celiac trunk.

Figure 5: VRT CT image in coronal plane showing. accessory renal artery on the both sides.

Figure 6: VRT CT image in oblique coronal plane showing accessory renal artery on right side and pre-hilar, late branching of left renal artery.

Celiac trunk and superior mesenteric artery [Table 2]
Among 200 patients evaluated in our study, a typical trifurcation of the celiac trunk was found in 158 (79%) patients. The typical trifurcation of celiac artery is defined as, the vascular trunk located at L1 level with the left gastric artery originating as the first branch and bifurcation of the celiac trunk into common hepatic & splenic arteries. A true trifurcation pattern in which all three branches of celiac artery originates at a single point was seen in 37 (23.4%) patients. Variations from this normal trifurcation pattern of celiac trunk were found in 42 (21%) patients.

As regards superior mesenteric artery a typical pattern is defined as a vessel originating within 1cm of origin of celiac trunk, which was seen in 186 (93%) patients. Variations of superior mesenteric artery were seen in 14 (7%) patients.
Anomalous origin of hepatic artery proper from superior mesenteric artery (hepato-mesenteric trunk) with celiac trunk giving origin to only left gastric & splenic artery (gastrosplenic trunk) was found in only 4 patients (2.0%) [Figure 2]. Right & left hepatic arteries arising separately from superior mesenteric artery & celiac trunk were seen in 11 (5.5%) cases. Right & left hepatic artery arising separately from celiac trunk was seen in 6 (3.0) cases. Also in 3 (1.5%) patients hepatic artery proper was seen arising directly from celiac trunk. The left gastric artery is seen arising from common hepatic artery in 3 (1.5%) patients. A left gastric artery arising directly from abdominal aorta with celiac artery dividing only into common hepatic and splenic arteries (spleno-hepatic trunk) was seen in 3 (1.5%) patients. Celiac-mesenteric trunk i.e. common origin of celiac trunk and superior mesenteric artery was seen in 2 patients (1.0%) [Figure 3]. In 19 (9.5%) patients, inferior phrenic artery is seen arising from celiac trunk instead of arising directly from abdominal aorta [Figure 4].

Table 2: Variations in Celiac Trunk & SMA.

Variation	No. of patients
Inferior phrenic artery arising from celiac trunk	19
Right & left hepatic arteries had their origins separately from celiac trunk & SMA	11
Right & left hepatic arteries arising separately from Celiac trunk	06
Celiac Mesenteric trunk	02
Hepatic artery proper: its origin from SMA along with presence of Gastro-splenic trunk	04
Hepatic artery proper arising directly from celiac trunk	03
Left gastric artery arising directly from Abdominal aorta with Spleno-hepatic trunk	03
Left Gastric artery arising from Common Hepatic artery	02

A total of 400 kidneys were analyzed in 200 patients included in our study. Out of these in 114 (57%) patients, a typical renal vasculature was found that included: a single renal artery supplying each kidney. Renal vasculature anomalies were observed in 86 patients (43.0%). [Table 3]

Table 3: Showing prevalence of anomalies of renal arteries.

No. of patients	Accessory renal artery		Branching of renal artery	
	Hilar	Polar	Early	Late
200	30	14	44	34

In our study, renal anomalies were divided into two groups; in first group we included patients in whom accessory renal artery was noted while second group included patients showing branching of renal artery before it enters the hilum (if branching occurs within 2 cm of its origin from the aorta it is termed early branching else it is defined as late branching; normal branching of renal artery is observed at the renal hilum).

In patients with accessory renal arteries, 2 patterns were identified; one in which accessory artery enters the kidney at its poles (polar arteries; superior and inferior) and another in which accessory artery enters at the hilar region (Hilar arteries). Accessory renal arteries were seen in 44 (22.0%) patients (Hilar artery in 30 patients and Polar artery in 14 patients) while abnormal branching of renal artery was seen in 78 (39.0%) patients of which 44 patients revealed early branching & rest revealed late branching [Figures 5 & 6].

No anomaly was seen in the origin of Inferior mesenteric artery.

DISCUSSION

Traditionally, conventional angiography is considered as gold standard imaging modality in evaluating the branches of abdominal aorta but it is marred by number of shortcomings; the most important of which is lack of extra-vascular information despite large amount of radiation and iodinated contrast dosage to the patient. This demerit has been largely overcome by MDCT (both routine & angiographic) scans which are not only very rapid but also provide simultaneous information about other structures in abdomen, thus helping in better preoperative planning for surgical & interventional endovascular procedures.

In our study, we found that more than half of the patients (55%) have some form of anomaly related to branching of abdominal aorta which is significantly high.

In our study, only 79% patients had normal trifurcation pattern of celiac trunk branching and rest showed presence of variations. Vandamme and Bonte in their study reported higher incidence i.e. 86% of classic trifurcation celiac trunks.[4] However, Michels found lower incidence i.e. only 55% of trifurcation of celiac trunk.[5] This suggests demographic variation in branching of abdominal aorta that needs consideration.

As regards renal artery variations, Kurcz et al who conducted a study on 267 patients reported an incidence of 42.2%, which is similar to that found in our study.[6] This suggests relative stability in the renal artery morphology among patients from different geographical background.

The study conducted by Satyapal et al revealed 17.4% incidence of accessory renal artery had which is close to that we found in our study (22.0%) signifying higher incidence in our demographic conditions.[7]

CONCLUSION

Great variability in abdominal vasculature makes detection of anomalies of abdominal aorta extremely important in present era of laparoscopic / robotic surgeries and various radiological interventional procedures in the abdominal region. As MDCT imaging technique facilitates fast & complete evaluation of abdominal aorta & its branches in a noninvasive manner even during routine abdominal examinations irrespective of number of phases, hence radiologists should recognize & describe the encountered unsuspected anomalies for future reference or predicting prognosis.

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