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ORIGINAL ARTICLE

Multi-Detector Computed Tomographic Angiography In Evaluation Of Inferior Vena Cava Anomalies And Abnormalities.

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Abstract

Background: Multidetector computed tomographic (MDCT) angiography is considered the best modalityforthethree-dimensional delineation of the Inferior Vena Cava (IVC). Knowledge of the broad spectrum of congenital anomalies and pathologic conditions affecting the inferior vena cava (IVC) is important.

Aim of the Study: To assess the role of MDCT angiography with multiplanar reformation (MPR) and three-dimensional (3D) reconstruction in the delineationofinferior vena cava anomalies and abnormalities.

Method: The study was done in the period from April 2019 to March 2020in Zagazig university hospitals. Thirty patients were included (70% males and 30% females; age range: 20-55 years), who had MDCT angiography using a 128-slice MDCT scanner (Ingenuity Phillips health care, best Netherlands).

Results: In our study, IVC thrombosis was the most commonly detected abnormality in 17 patients (56.6%), followed by Budd-Chiari syndrome in 5 cases (16.6%) then three cases (10%) with heterotaxy syndrome, only one case (3.3%) with double IVC and another one (3.3%) with left-sided IVC. Regarding 17 patients found with IVC thrombus, 5 cases (29.5%) with bland thrombus were detected, while 12 cases (70.5%) with tumor thrombus extension were detected. IVC tumor thrombus in 12 patients were distributed as follow; Among 12 patients examined with tumor thrombus, the most commonly detected type extended from HCC presented in 7 cases (58.3%), followed by RCC in 3 cases (25%), then one case with pancreatic mass and one case with ovarian mass with the percentage of 8.3% for each.

Keywords:

MDCT angiography, Inferior Vena Cava, Thrombus, Budd-Chiari syndrome.

1. Introduction

Inferior Vena Cava (IVC) is affected by multiple abnormalities so that imaging has asignificant role in the delineation and management of IVCabnormalities[1].

MDCT plays an important role in the detection of Budd-Chiari syndrome caused by membranous obstruction of the intrahepatic IVC. Intra-caval extension of malignant tumors arising in adjacent organs is more common than primary IVCmalignancy, and imaging can

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help accurately to determine the presence and extent of IVC tumor thrombus, information that is important for surgical planning [2].
Although Ultrasonography (US), specifically color doppler imaging, is considered good for the initial diagnosis. Limitations of US is its operator dependency;delineation of the IVC (especially the infrahepatic segment) may be difficult due to obesity or bowel gas. So, CT and MR imaging are essential for the diagnosis of IVC abnormalities and planning of treatment[3].
However, the radiologist must be aware that artifactual filling defects at CT and MR imaging may mimic true IVC thrombus; also, he must be able to easily differentiate true from pseudo-filling defects [2].
Familiarity with the imaging characteristics of theabnormalities that may affect the IVC is important for early detection and intervention [4].

2. Patients and Method

2.1. Patients

This study was done at the Radio-diagnosis department, ZagazigUniversity Hospital. A total number of 30 patients were included for elective MDCT angiography from April 2019 to March 2020.They were (70%) males and (30%)females; their ages ranged from 20 to 55 years. Referral by a physician for suspiciousinferior vena cava abnormality. We retrospectively evaluated patientsforIVC abnormalities. Our patients can be silent or have associated cardiac anomalies resulting in vascular or abdominal problems.

2.1.1. Patient Inclusion Criteria:

Our study included patients who underwent MDCT angiography, patients with suspected inferior vena cava abnormality, either accidentally discovered or suspected at doppler ultrasound, of the adult age group, including both genders.

2.1.2. Patient Exclusion Criteria:

Absolute contraindications (Patients with elevated kidney functions (Creatinine level ≥ 2 mg/dl) not on dialysis, allergy to contrast media, Pregnancy, morbid obesity).Relative contraindications (hemodynamic instability, renal diseases on dialysis, inability to maintain proper inspiratory breath-hold during the scan).
Full history taking, revision of previous laboratory and other vascularinvestigations,including (doppler US),was done prior to MDCT evaluation.Written informed consent was obtained from all participants; the study was approved by the ethical research committee of the Faculty of Medicine, Zagazig University; the study was performed according to the code of ethics of the world medical association (Declaration of Helsinki) for studies involving humans.

2.1.3. Patient preparation

Before the examination, the patient was asked to fast for 4 hours. Heart rate was controlled to 65-70 beats per minute. Respiration training was done to avoid respiratory artifacts. After that,anintravenous route was performed in the right ante-cubital vein (100 ml of ultravist) with a rate of 3 mL/s

2.2. Image acquisition

Routine CT sequence was a venous phase, which is obtained after a scanning delay of sixty seconds following injection. A triphasic study was performed in cases of HCC, where the arterial phase was detected with automated triggering. ROIis placed in the abdominal aorta just above the diaphragm with the density of 150 HU after the beginning of the scan; then, we gave 60 seconds delay for the portovenousphase;after that, 5 minutes delay for the delayed phase.

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2.3. Postprocedural evaluation of patient

After the scan, the patient is maintained under observation for 15 minutes to check the vital signs (pulse and blood pressure).

2.4. Image reconstruction and interpretation

Cases were analyzed on an advanced Philips workstation using axial images (as source images), Maximum Intensity Projection (MIP), multiplanar reformation, and volume rendering (VR) techniques.

2.5. Statistical analysis

Data were collected, coded, entered, and analyzed using Microsoft Excel software. Data were then imported into Statistical Package for the Social Sciences (SPSS version 23.0) software for analysis. Qualitative data were represented as numbers and percentages, and quantitative data were represented by mean ± SD.

3. Results

3.1. MDCT findings of IVC abnormalities.

According to findings on MDCT, our final diagnosis was classified into the following (Table 1): IVC thrombus 17 cases, Budd Chiari syndrome (5 cases), Heterotaxy syndrome with interrupted IVC (3 cases), Double IVC (1 case), left-sided IVC (1 case). Three cases included in our study showed normal MDCT findings with no IVC abnormality. The most common IVC pathology in our study was IVC thrombus,
either tumor thrombus (12 cases) or bland thrombus (5 cases).

(Table 1).

MDCT finding	**Number(N)**	**Percentage (%)**
IVC thrombus	**17**	**56.6**
Budd Chiari syndrome	**5**	**16.6**
Heterotaxy syndrome with interrupted IVC	**3**	**10**
Double IVC	**1**	**3.3**
Left sided IVC	**1**	**3.3**
No IVC abnormality (Normal finding)	**3**	**10**

3.2. MDCT finding of IVC thrombus in 17 patients.

Among 17 patients detected in our study with IVC thrombus, 12 patients (70.5%) with tumor thrombus, while 5patients (29.5%) had bland thrombus

(Table 2 and Figure1).

MDCT finding of IVC thrombus	Number	Percentage (%)
Bland thrombus	5	29.5
Tumor thrombus	12	70.5

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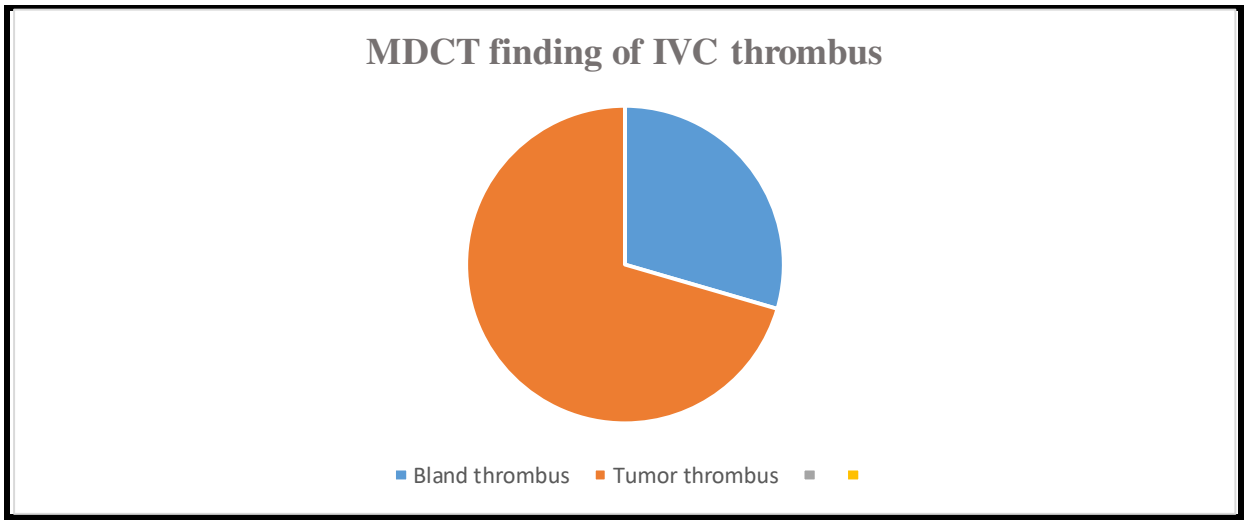

3.3. IVC tumor thrombus among 12 patients

Among 12 patients examined with tumor thrombus, the most commonly detected type extended from HCC presented in 7 cases (58.3%), followed by RCC in 3 cases (25%), then one case with pancreatic mass and one case with ovarian mass, 8.3% for eac (Table 3).

IVC tumor thrombus	Number (N)	Percentage (%)
Hepatocellular carcinoma	**7**	**58.3**
Renal cell carcinoma	**3**	**25**
Pancreatic mass	**1**	**8.3**
Ovarian mass	**1**	**8.3**

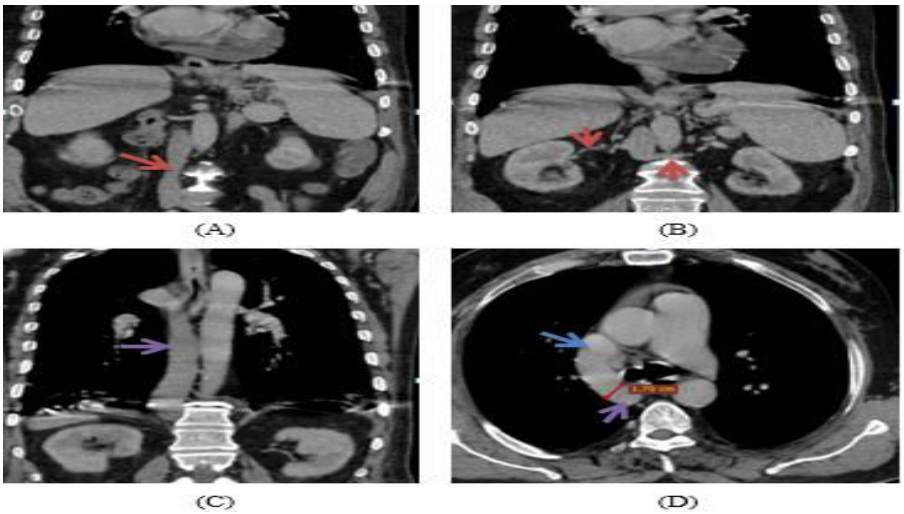

Fig (2): 30-year-male patient presented to our department complaining of abdominal pain.**(A)** Coronal CT image showing infrahepatic portion of IVC (orange arrow).**(B)** Coronal CT image showing right and left renal veins draining to IVC (orange arrows).**(C)** Coronal CT image showing azygos vein as a continuation of IVC in the chest (arrow).**(D)** Axial CT image showing azygos vein, which is dilated measuring 17 mm (arrow) draining into SVC (blue arrow). **CT picture suggesting;Intrahepatic interruption of IVC with azygos continuation.**

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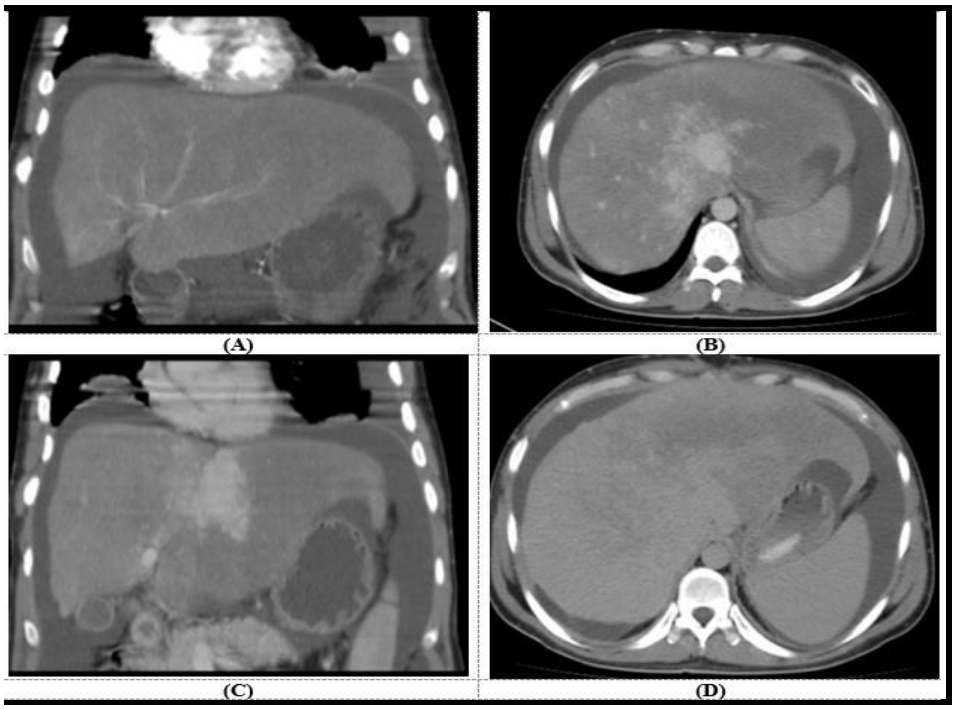

Fig (3): 40-year-female patient presented to our department complaining of abdominal pain. **(A)** Coronal CT image (arterial phase)shows enlarged size liver attenuated hepatic veins. Gallbladder shows increased wall thickness without gallstone. Moderate ascites with associated left sided pleural effusion.**(B)& (C)** Axial and **c**oronal CT images (Porto-venous phase) showing enhancement of the caudate lobe and central liver around the inferior vena cava, inhomogeneous mottled liver (nutmeg liver).Peripheral zones of the liver appear hypoattenuating because of reversed portal venous blood flow.**(D)** Axial CT(Delayed phase) image showing delayed enhancement of the peripheral liver with accompanying central low density (flip-flop appearance).**CT picture suggesting;Budd-Chiari syndrome.**

4. Discussion

The imaging features of different IVC congenital anomalies, including double IVC, left IVC, absence of the infrarenal IVC, retrocaval ureter, retroaortic and circumaortic left renal vein, portocaval shunt and interruption of the IVC with azygous or hemizygous continuation [1].

IVC artifactual filling defects are common and caused bythemixing of enhanced blood from the renal veins with unspecified blood from the lower extremity. An inexperienced radiologist can occasionally mistake pseudolesionsfor a clot. So delayed imaging shows complete IVC opacificationin doubtful cases that clarifies the finding[5].

Once a true filling defect of the IVC is detected, detection of the cause (benign or malignant), and its extent will help in clinical treatment [6]. Bland thrombus of the IVC could be an isolated thrombus. However, it is commonly resulting from deep vein thrombosis of the lower limbs [7].

Differentiation between tumor and bland thrombus is easy by MDCT in sagittal and coronal reconstructions that allow delineation of direct continuity between the thrombus and the primary tumor. Also, expanding the vessel lumen and enhancing the filling defect help differentiate bland frommalignant thrombus [6].

In our study, we found that the most common abnormality was IVC thrombosis which represents about (56.6%) followed by Budd-Chiari syndrome (16.6%), heterotaxy syndrome

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with interrupted IVC (10%), then Double IVC (3.3%), and left-sided IVC (3.3%). Three cases included in our study showed normal MDCT findings with no IVC abnormality.
Our study agreed with Khamis M et al. [3], who found that IVC thrombosis represents about 50 % of the studied group.
Regarding Budd Chiari syndrome, we agreed with Ferral et al.[8], who stated that Budd Chiari syndrome is an uncommon finding that requires accurate diagnosis and adequate therapy. However, we disagreed with Khamis et al. [3], who found that Budd Chiari represents about 35% of the studied group.
By shedding light on heterotaxy syndrome with IVC interruption, we found that we agreed with vijayvergiya et al. [9], who reported that this congenital anomaly is not common.
Regarding Double (right and left) IVC, We agreed with Kandpal et al. [1], who reported that double IVC has a prevalence of 1% to 3% which is caused by the persistence of right and left supracardinal veins.
We also agreed with Kandpal et al. [1] regarding left sided IVC, who stated that Left IVC represents about 0.2% to 0.5% and is caused by a persistent left supracardinal vein.
Double IVC is similar to left IVC in their clinical implications and could be mistaken as adenopathy, particularly when contrast enhancement of IVC is faint resulting from thrombosis or technical reasons [10].
In this study, we found that among 17 patients detected with IVC thrombus, there are 12 patients (70.5%) with tumor thrombus while five patients (29.5%) had bland thrombus.
Our results come in agreement with Khamis et al.[3], who found 35 % of the studied group with tumor thrombosis while the percentage of the bland IVC thrombosis was 25 % of the studied group. We disagreed with McAree et al. [11], who reported that although the neoplastic association with IVC thrombosis, this condition remains rare and is only found in 0.07% of hospitalized patients with associated neoplasms.
In our study, we found that among 12 patients examined with tumor thrombus, the most commonly detected type as a complication of HCC presented in 7 cases (58.3%), followed by RCC in 3 cases (25%), then one case with pancreatic mass and one case with ovarian mass with the percentage of 8.3 for each.
We agreed with Wakayama et al. [12],who stated that hepatocellular carcinoma (HCC) is a highly malignant tumor with a high probability for invasion of intrahepatic blood vessels,including the portal vein or hepatic vein with a further extension of the thrombus to IVC.
We also agreed with Blute et al. [13]. He stated in his study that involvement of the IVC represents up to 35% of patients with renal cell carcinoma (RCC).
We found that Mizumoto et al. [14] agreed with our study as they reported that direct invasion of the IVC as a complication of pancreatic cancer is uncommon.
We found in our study that IVC thrombosis complicated by ovarian mass represents about 8.3 %. In contrast to Testani et al. [15], who found that due to the aggressive nature of the ovarian carcinosarcoma, they have a high rate of metastases with venous thromboembolism affecting IVC through the gonadal vein.

5. Limitations

The only evident limitation to the study is the small sample size which can be avoided by involvinga larger sample size

6. Conclusion

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In conclusion, the IVC is host to a wide range of pathologic conditions and congenital anomalies. Imaging provides an accurate assessment of congenital anomalies and pathological obstruction of the intrahepatic IVC and is valid in diagnosingthe presence of thrombus. Imaging is also helpful in limiting the differential diagnosis. Radiologists must be aware of the potential pitfalls of IVC imaging and distinguish between true and pseudo-filling defects.

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Data Availability Statement: The data presented in this study are available on request from the
corresponding author.

Conflicts of Interest: The authors declare no conflict of interest.

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