



## **Role of CT Angiography in Diagnosis of Reno-Vascular Abnormalities**

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### **Authors' contributions**

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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### **ABSTRACT**

**Background:** Reno-vascular disease is a complex disorder, the most common cause of which is RAS. Multi detector computed tomography angiography (MDCTA) plays an important role in assessment of the renal vasculature. Despite conventional angiography is still considered the gold standard in reno-vascular imaging, MDCTA is increasingly used as it is less invasive, easily applicable and available.

**Aim of the Study:** In our study we aimed to assess the role of CT Angiography in diagnosis of renal vasculature abnormalities.

**Patients and Methods:** This prospective study was carried out at The Radio-diagnosis and Medical Imaging Department in our institute, conducted on 40 Patients who are clinically suspected to have reno-vascular abnormalities in the period from September 2018 to February 2021. Their ages ranged from 33 to 56 years old.

**Results:** Based on CTA findings, out of 40 patients, 6 (15%) patients were confirmed to have accessory renal arteries, 6 (15%) patients had renal artery aneurysm, 6 (15%) patients had nutcracker syndrome, 6 (15%) patients had dual venous drainage of both kidneys, two of them

showed retro-aortic left renal vein & 10 (25%) patients were confirmed to have renal artery stenosis. **Conclusion:** CT Angiography with multiplanar reconstruction and three-dimensional display is valuable in studying patients with reno-vascular lesions involving the proximal renal vessels. MDCT angiography is advantageous being a non-invasive technique that can be done on outpatient basis without pre or post-procedure admission, no special post-procedure care and less cost.

*Keywords: Multidetector computed tomography angiography; reno-vascular abnormalities.*

## 1. INTRODUCTION

CT angiography, which is a rapid and non-invasive method, has become a widely used imaging modality in imaging of renal vascular pathologies. The most common renal vascular pathologies include renal artery stenosis, renal artery aneurysms, dissection, vasculitiditis and fibromuscular dysplasia [1].

MDCT angiography is advantageous being a non-invasive technique that can be done on outpatient basis without pre or post-procedure admission, no angiographic team or equipment needed, no special post-procedure care, less cost [2].

The introduction of multi-detector row computed tomography (MDCT) revolutionized the technology with regard to the speed of scanning and the quality of three-dimensional (3D) images. This technique can depict the arterial and venous vasculature, the collecting system and renal parenchyma in a single study [3]. Although CT and magnetic resonance (MR) imaging have comparable accuracy, CT has a higher resolution than MR and is more technically robust [4,5]. The disadvantages of CT angiography are that the patient is exposed to both ionizing radiation and potentially nephrotoxic contrast material.

### 1.1 Aim of the Study

The aim of this work is to assess the role of CT Angiography in diagnosis of renal vasculature abnormalities.

## 2. PATIENTS AND METHODS

This prospective study was carried out at The Radio-diagnosis and Medical Imaging Department in our institute, conducted on 40 Patients who are clinically suspected to have reno-vascular abnormalities in the period from September 2018 to February 2021.

### 2.1 Inclusion Criteria

Patients who are clinically suspected to have reno-vascular abnormalities were presented by malignant hypertension, uncontrolled hypertension, unexplained hypertension in young age, unexplained proteinuria & unexplained hematuria.

### 2.2 Exclusion Criteria

Subjects who refuse to participate in the research.

Pregnant women.

Contraindications or Hypersensitivity to contrast media Impairment of renal functions (serum creatinine level above 2 mg/dl)

### 2.3 Risks and Ethical Consideration

1. Any unexpected risk encountered during the course of the research was cleared to the participants as well as to the Ethical Committee on time.
2. Every patient received an explanation to the purpose of the study and the benefits and risks of the procedure.
3. There were adequate provisions to maintain privacy of participants and confidentiality of data through:

Each participant had a code number.

All data and investigations of subjects were confidential with a private file for each patient.

The results of the research were used only for the scientific purpose.

All given data was used for the current medical research only.

The name of the patient was hidden from the photos used in the study or published at the research paper.

## 2.4 Methods

### 2.4.1 All patients in this study were subjected to the following

Complete history taking (hypertension, diabetes mellitus, hypersensitivity...etc.).

Full clinical examination.

Laboratory investigations (Blood urea, serum creatinine& Urine analysis).

Renal CT angiography.

### 2.4.2 Technique

Patients were instructed to fast for food for 6-8 hours prior to examination & asked to continue adequate simple water intake up to 3 hours prior to examination.

Patients were positioned supine on the CT table in the "head first" position with arms resting comfortably above the head.

An 18-20 gauge cannula was placed into a superficial vein within the antecubital fossa. Before the contrast material was administered by the injector, saline injections were manually administered at a high rate of flow, with the patient's arms in the scanning position. This was done to ensure the successful cannulation of the vein.

An initial scout image was taken to determine the table coverage performed from T12 vertebra through mid-pelvis in cranio-caudal direction.

The scanning parameters used were as follow; Gantry rotation period= 0.5 second, slice thickness= 3 mm, slice pitch= 0.6, table speed= 15 mm per rotation, the current= 200 mA, X-ray tube voltage= 120 KV.

One hundred twenty milli liters of non-ionic contrast media (Iopromide, 370 mg/ml) (Ultravist 370, Schering, Germany) was injected at a rate of 3 ml/s using a commercially available automatic injector.

Using an automatic bolus tracking method, scanning was initiated, with a delay of 5 s after

triggering at a threshold of 100 HU in the region of interest at the supra renal level of abdominal aorta.

- (a) Arterial phase: with automatic detection of contrast media (about 15 -20 seconds after start of contrast medium injection & is marked by maximum opacification of the renal arteries)
- (b) Venous phase: The renal veins usually opacify at late arterial phase.
- (c) Corticomedullary (angionephrographic) phase: Starts after about 30- 40 seconds after the start of contrast medium injection.
- (c) Nephrographic phase: Starts at about 65- 90 seconds after the start of contrast medium injection.
- (d) Delayed phase: Starts at about 7-10 minutes after the start of contrast medium injection.

## 2.5 Image Processing

Axial images were reconstructed with a standard algorithm and post processing was performed on a commercially available workstation. Major vessels were visualized with volume rendering (VR) & maximum intensity projection (MIP).

## 2.6 Image Analysis

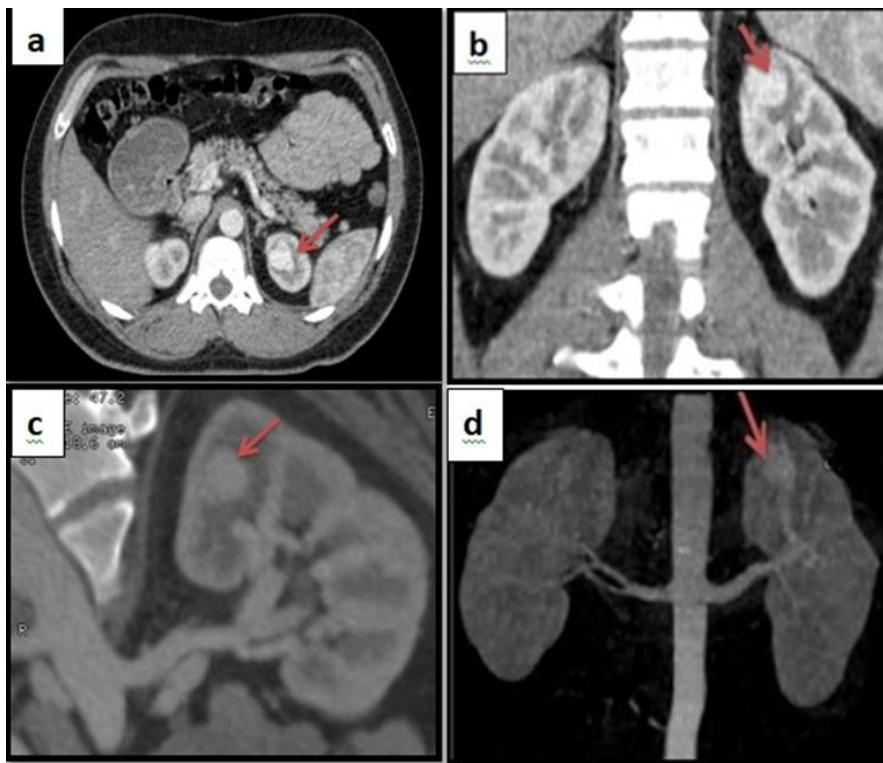
Analysis of image data was focused on the morphology of renal vasculature for reno-vascular diseases (stenosis, aneurysms, etc.) & reno-vascular variants.

## 3. RESULTS

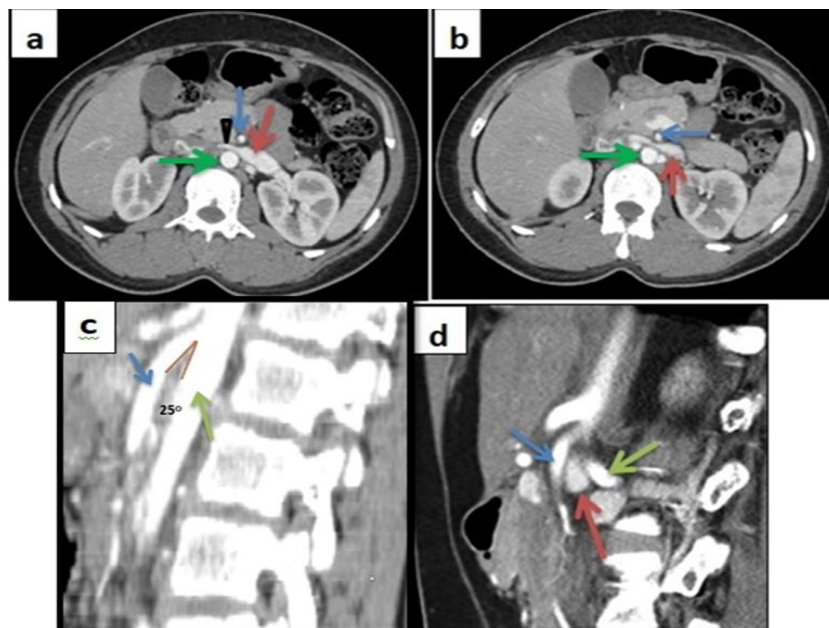
This study was carried out on 40 patients, 6 (15%) patients were confirmed to have accessory renal arteries, 6 (15%) patients had renal artery aneurysm, 6 (15%) patients had nutcracker syndrome, 6 (15%) patients had dual venous drainage of both kidneys, two of them showed retro-aortic left renal vein & 10 (25%) patients were confirmed to have renal artery stenosis. (Table 1)

**Table 1. Findings in CT Angiography**

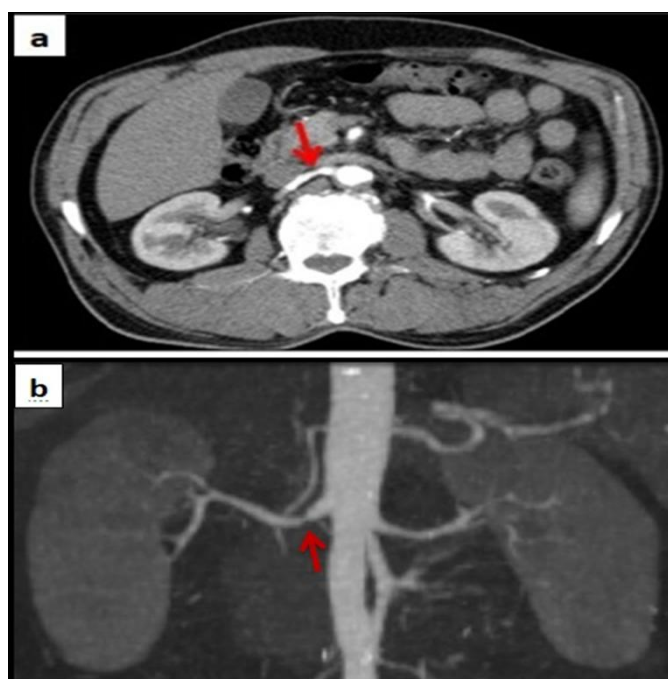
|                                      |    |       |
|--------------------------------------|----|-------|
| Normal                               | 6  | 15.0% |
| Accessory renal artery               | 6  | 15.0% |
| Renal artery stenosis                | 10 | 25.0% |
| Renal artery aneurysm                | 6  | 15.0% |
| Nutcracker syndrome                  | 6  | 15.0% |
| Dual venous drainage of both kidneys | 6  | 15.0% |
| Retro-aortic left renal vein         | 2  | 5.0%  |



**Fig. 1. (a) Axial renal CT angiography (venous phase), (b, c & d) Maximum intensity projection (MIP) reformatted images (venous phase) showing patent saccular aneurysm arising from the arcuate branch of the upper segmental artery at the upper pole of the left renal artery (red arrow)**



**Fig. 2. (a & b) Axial renal CT angiography (venous phase) show beak sign (arrow head), which is narrowing of left renal vein (red arrow) between aorta (green arrow) and superior mesenteric artery (blue arrow), (c & d) Sagittal renal CT angiography (arterial phase) show compression of left renal vein (red arrow) between aorta (green arrow) & superior mesenteric artery (SMA) (blue arrow). The angle between aorta & superior mesenteric artery (SMA) is 25°**



**Fig. 3. (a)Axial Renal CT angiography (arterial phase), (b)Maximum Intensity Projection (MIP) reformatted image showing stenosis (60 % luminal narrowing) at the proximal part of right renal artery (red arrow)**

Case 1 in the present study was a 52-year-old male patient complaining of unexplained hypertension & hematuria. Renal function tests were performed, blood urea was 32 mg/dl & serum creatinine was 0.8 mg/dl. Renal Doppler Ultrasound was performed & showed an upper polar round shaped structure with an arterial flow within. Renal CT angiography was performed to confirm the diagnosis.

Case 2 in this study was a 33-year-old male patient complaining of left flank pain, hematuria, dysuria & painful left testis. Renal function tests were performed, blood urea was 28 mg/dl and serum creatinine was 0.9 mg/dl. The patient was unsuitable to perform Doppler Ultrasound even after preparation. Renal CT angiography was performed.

Case 3 in the present study was a 49-year-old male patient complaining of unexplained hypertension. Renal function tests were performed, blood urea was 33 mg/dl & serum creatinine = 0.9 mg/dl. The clinician & the patient refused to perform Doppler Ultrasound.

#### 4. DISCUSSION

CT angiography has become a widely used imaging modality in imaging of renal vascular

pathologies being a non-invasive technique that can be done on outpatient basis without pre or post-procedure admission, no angiographic team or equipment needed, no special post-procedure care as conventional angiography & less cost [6].

The aim of this work is to assess the role of CT Angiography in diagnosis of reno-vascular abnormalities.

All patients in this study underwent complete history taking (hypertension, diabetes mellitus, hypersensitivity etc.), full clinical examination, laboratory investigations (Blood urea, serum creatinine & Urine analysis) & Renal CT angiography.

Reno-vascular disease is a complex disorder, the most common cause of which is RAS [7].

Occlusive diseases of the renal artery can result in hypertension, renal dysfunction and ultimately renal failure. Renal artery stenosis (RAS) is responsible for secondary hypertension in 5% of adults and atherosclerosis is the most common etiology among elder population [8].

The renal aneurysm is usually discovered incidentally during imaging. CTA with 3D display can play a primary or complementary role in

demonstrating the origin of the aneurysm and its relationship to the renal arteries [9].

Nutcracker (NC) syndrome is characterized by left-sided renal bleeding due to compression of the left renal vein (LRV) in the fork between the abdominal aorta and the superior mesenteric artery (SMA). These result in left renal venous hypertension leading to the development of collateral veins with intra renal and peri renal varicosities, which can cause hematuria if the thin-walled septum separating the veins from the collecting system ruptures. The main presenting symptom is hematuria, with or without left flank pain [10].

The diagnosis of NCP can be established by venographic imaging or IA-DSA. Since these examinations are relatively invasive, a less-invasive method for diagnosis is desirable and several methods to confirm the presence of compression of LRV have been proposed for this purpose: CTA, Simple MRI and MRA [11].

Retroaortic left renal vein [RLRV] is a vascular anomaly resulting from errors in the embryological development of left renal vein. It is one of the most common congenital anomalies involving renal veins [12]. RLRV is located between the abdominal aorta and the lumbar vertebral body instead of in front of abdominal aorta in normal left renal vein. RLRV anomalies, although are not rare but it is usually overlooked and only small minority of cases show clinical symptoms [13].

In the current study, based on CT Angiography findings, 6 (15%) patients were confirmed to have accessory renal arteries, 6 (15%) patients had renal artery aneurysm, 6 (15%) patients had nutcracker syndrome, 6 (15%) patients had dual venous drainage of both kidneys, two of them showed retroaortic left renal vein & 10 (25%) patients were confirmed to have renal artery stenosis.

In the cohort of Sameh W et al., 2013 reported that accessory renal arteries were seen in 21.3% of donors [14].

In contrast with the present study, Megally HI et al., 2011 study conducted on 10 patients, reported that 6 patients with renal aneurysms, 2 patients with nutcracker syndrome, 1 patient with AVM and 1 patient of renal artery stenosis, who underwent angioplasty via balloon dilatation. Also, the study of Reginelli A et al., 2015

reported that 69% of patients showed a single renal artery, one on each side, with multiple arteries in 31%. With regard to the venous drainage, 89.8% of patients showed a single renal vein, one on each side with multiple veins in 10.2%, while 23.8% showed a retro-aortic course of the renal vein [15,16].

## 5. LIMITATION OF THE STUDY

This study was limited by the small number of participating subjects & lack of the follow up of the patients after diagnosis if they underwent surgical intervention or not.

## 6. CONCLUSION

CT Angiography plays an important role in the evaluation and diagnosis of the primary renovascular diseases & renovascular variants. CT Angiography with multiplanar reconstruction and three-dimensional display is valuable in studying patients with renovascular lesions involving the proximal renal vessels. MDCT angiography is advantageous being a non-invasive technique that can be done on outpatient basis without pre or post-procedure admission, no special post-procedure care and less cost.

## 7. RECOMMENDATIONS

Further studies on large geographical scale and on larger sample size to emphasize our conclusion.

More patients, follow-up, and multicenter experience are all necessary to accurately figure out the role of CT Angiography in diagnosis of renovascular abnormalities.

## CONSENT

After approval from institutional ethical committee, an informed consent was taken from each patient.

## ETHICAL APPROVAL

The study was approved by ethical committee number 32344.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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