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# A Radiological Study of Renal Artery Pathologies by Renal Doppler, CT Renal Angiogram and Non-Contrast Resonance Renal Angiogram

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## Abstract

***Background:*** *Renal artery pathologies are important causes of uncontrolled hypertension, accelerated hypertension, and the presence of hypertension in the younger age group. It has been found that carotid and coronary artery disease co-exists with renal pathologies.* ***Aim:*** *The present study aimed to evaluate the performance of Renal Doppler, Computed Tomographic Renal Angiography, and Non-enhanced Magnetic Resonance Renal Angiography for diagnosis of renal pathologies.* ***Methods:*** *This is a prospective comparative study was done at the Department of Radio-Diagnosis, Prathima Institute of Medical Sciences, Nagunur, Karimnagar, Telangana State. Initially, the Doppler examination was performed on suspected patients of reno-vascular hypertension and interpretations were made. Then after looking at the renal parameters the patient is subjected to CTA, NE MRA, or both. N=53 patients who are clinically suspected of renal artery pathologies were included in the study.* ***Results:*** *Out of the total n=53 patients, atherosclerosis was diagnosed among n=10 patients, of them the maximum number belongs to the male population (n=6). Vasculitis is diagnosed in n= 9 patients of them the maximum number belongs to the female population (n=8). Atherosclerotic disease (n=10) was more found in the above 60 years age group population, vasculitis is more seen in the 21-40 years age group. Variant or accessory renal arteries are more found in the 41-60 years age group. Among n=20 patients with renal artery stenosis, 60% (n=12) are having bilateral main renal artery stenosis, 40% (n=8) are having unilateral main renal artery stenosis.* ***Conclusion:*** *The results of present study concluded that ultrasound renal Doppler and non-contrast magnetic resonance renal angiography can be used as initial screening modalities to evaluate renal artery stenosis, with NC-MRA having slightly high sensitivity and specificity, US renal Doppler allowing for functional analysis and CTA is the best modality of choice to characterize the pathology and to visualize variant anatomy when compared with ultrasound renal Doppler and non-contrast MRA.*

***Keywords****: Renal Artery pathologies, Renal Doppler, CT Renal Angiogram, Non-contrast Resonance Renal Angiogram*

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## Introduction

Renovascular diseases are complex disorders that may ultimately lead to progressive loss of renal function. The various causes of renal artery stenosis include atherosclerosis, traumatic thrombosis, non-traumatic thrombosis, and thromboembolism. [1] The most common cause of renal artery stenosis is atherosclerosis which accounts for 90% of cases. When atherosclerosis is the cause of renal stenosis it is associated with syndromes such as renovascular hypertension, ischemic nephropathy, and pulmonary edema. [2] Atherosclerosis in Renal artery stenosis usually develops near Ostia with 10mm of the aortic wall. Recent studies have found that the presence of atherosclerotic plaque in the renal artery is indicative of the presence of plaque at other sites of the body such as carotid artery and coronary arteries which can add to the

cardiovascular risk burden. [3,4] Evidence indicates that reduction of internal diameter from 50-70% is considered hemodynamically significant depending on the imaging modality used to determine stenosis. [5] The non-invasive diagnostic tests such as ultrasound, MRI, and CT angiography, Intra-arterial digital subtraction angiography (IA-DSA) remain the standard for diagnosis of renal artery stenosis. However, being an invasive procedure, it has a small risk of serious complications such as arterial dissection, adverse reactions to the loss of kidney function. With this background, we in the present study tried to evaluate patients presenting with uncontrolled hypertension, accelerated hypertension, hypertension in young, carotid or coronary artery disease as these are suspected of having renal artery pathologies. To study the diagnostic performance of Renal Doppler, Computed Tomographic Renal Angiography, Non-enhanced Magnetic Resonance Renal Angiography.

## Materials and Methods

This is a prospective comparative study was done at the Department of Radio-Diagnosis, Prathima Institute of Medical Sciences, Nagaur, Karimnagar, Telangana State. The study protocol was approved by the Institutional Ethical committee permission. Written consent was obtained from all the participants of the study. The study was done on patients clinically suspected renal artery pathologies, who were scheduled for doppler ultrasound, CTA, and or NE-MRA.

***Inclusion criteria:***

1. All patients suspected of renal artery pathologies
2. All age groups

***Exclusion criteria:***

1. Patients in whom MR was contraindicated due to any reason.
2. Known allergy to contrast media
3. Severe renal insufficiency (creatinine >2.5mg/dl)

Initially, the Doppler examination was performed on suspected patients of reno-vascular hypertension, and interpretations were made by on staff radiologist. Then after looking at the renal parameters the patient is subjected to CTA, NE MRA, or both. N=53 patients who are clinically suspected of renal artery pathologies. They are evaluated with ultrasonography (PHILIPS HD30 machine) for doppler, 128 slices CT scanner (PHILLIPS INGENUITY), and 1.5T MRI NE MRA (1.5T PHILIPS ACHIEVA MRI SCANNER).

***Renal Doppler***

With the patient in the supine position and the head of the bed elevated about 30 degrees. A low-frequency scan head (2.5–5.0 MHz) is used to depict the abdominal aorta and renal arteries (RAs). The two main approaches for imaging the RAs are through the anterior abdominal wall and the flank. In most cases, the anterior approach is used to evaluate the main RAs. The flank approach may be used to image both the intrarenal vasculature and the main RAs. Each of these windows has limitations, which are dependent on individual body habitus and several other variables, such as the ability of the patients to hold their breath. In selected cases, the posterior approach can be used.

***MDCT Renal Angiography***

Risks and benefits of the procedure were explained to the patient clearly. Patients were asked to fast for 6 hours before the study routine investigations were ordered, non-invasive color doppler results were recorded. MDCT Renal Angiogram Protocol all patients were examined with a 128 slice MDCT scanner (PHILLIPS INGENUITY 128 SLICE NETHERLANDS) using standard renal angiogram CT protocol.

***NE-MR Angiography***

Patient consent was taken. Risks and benefits of the procedure were explained to the patient clearly. History of surgeries with any metallic implantation is noted. H/O claustrophobia was ruled out in all patients. All metallic belongings and ornaments are asked to remove. Patients are asked to change clothing with a special gown provided to them in the MR changing room. The patient is then tested with an electronic metal detector to see whether any metal objects remain. Detailed patient history was taken, medications used, routine investigations, non-invasive color doppler results were recorded.

***NE-MRA Protocol***

All patients were examined with 1.5 Tesla MRI scanner (Phillips ACHEIVA1.5T Netherlands)

using standard renal angiogram MRA protocol. The analysis of the data is based on the comparison of Doppler indices of renal arteries at the origin, hilum, intraparenchymal and analysis of main, segmental arteries with NE-MRA and CECT RENAL ANGIOGRAPHY (taking CTA as standard).

## Results

The present study included a total number of n=53 cases including both males and females. Among the total of n=53 cases, 52.83% (n=28) are female patients and 47.16% (n=25) are male patients giving female to male ratio of 1.12:1. Among n=53 cases, the youngest patient was 4 days old and the oldest patient was 71 years old.

**Table 1:** Age-wise distribution

| Age (Years) | Number | Percentage |
|---|---|---|
| 0-10 | 3 | 6 |
| 11-20 | 5 | 9 |
| 21-30 | 9 | 17 |
| 31-40 | 11 | 21 |
| 41-50 | 9 | 17 |
| 51-60 | 5 | 9 |
| 61-70 | 10 | 19 |
| 71-80 | 1 | 2 |

Among n=53 patients 56.6% (n=30) presented with young/uncontrolled/resistant/accelerated hypertension, 32.72% (n=18) are known atherosclerotic disease patients and 9.09% (n=5) are cases of peripheral arterial disease/carotid disease/coronary artery disease.

**Table 2:** Frequency of presenting symptoms

| Clinical Feature | Number | Percentage |
|---|---|---|
| Young hypertensives (<40 years) and resistant/ malignant/accelerated hypertension | 30 | 57 |
| Known atherosclerotic disease | 18 | 34 |
| Peripheral arterial disease/ carotid disease/coronary artery disease | 5 | 9 |

**Table 3:** Normal and abnormal patients

| Diagnosis | Number | Percentage |
|---|---|---|
| Normal (No Main or Accessory Renal Artery Stenosis) | 10 | 19 |
| Abnormal (Renal Artery Stenosis Present/Any Other Pathology) | 43 | 81 |

Out of the total n=53 patients, atherosclerosis was diagnosed among n=10 patients, of them, the maximum number belongs to the male population (n=6). Vasculitis is diagnosed in n=9 patients of them the maximum number belong to female population (n=8). Atherosclerotic disease (n=10) was more found in the above 60 years age group population, vasculitis is more seen in the 21-40 year age group. Variant or accessory renal arteries are more found in the 41-60 year age group. Among n=20 patients with renal artery stenosis, 60% (n=12) are having bilateral main renal artery stenosis, 40%(n=8) are having unilateral main renal artery stenosis.

**Table 4:** Spectrum of renal artery pathologies

| Disease | Number | Percentage |
|---|---|---|
| Atherosclerosis | 10 | 23 |
| Fibromuscular dysplasia | 1 | 2 |
| Takayasu's arteritis | 8 | 19 |
| Accessory renal arteries | 11 | 26 |
| Renal/aortic aneurysm | 3 | 7 |
| Renal/aortic dissection | 4 | 9 |
| Idiopathic/structural | 6 | 14 |
| Total | 43 | 100 |

The etiologies of bilateral main renal artery stenosis are 16.66% (n=2) is due to congenital renal artery stenosis, 16.66% (n=2) is due to atherosclerosis, 66.66% (n= 8) is due to vasculitis which is the common reason for bilateral main renal artery stenosis in this study population. Among 40% (n=8) of unilateral renal artery stenosis, Atherosclerosis 75.00% (n=6) is the major cause of unilateral renal artery stenosis. Among the total number 16 accessory renal arteries evaluated, 75% (n=12) are taking origin from the abdominal aorta. Among 106 renal arteries evaluated with Doppler ultrasound for renal artery stenosis, 74% (n=78) showed normal indices of renal doppler, 26.41% (n=28) showed raised indices, giving high suspicion of renal artery stenosis.

**Table 5:** Cross comparison of Stenosis and Non-Stenosis of Renal Arteries with US Doppler, MR Renal Angiogram, and CECT Renal Angiogram

| CT | | | MR | | Total |
|---|---|---|---|---|---|
| | | | Negative | Positive | |
| Negative | US | Negative | 14 | 1 | 15 |
| | | Positive | 3 | 0 | 3 |
| | | Total | 17 | 1 | 18 |
| Positive | US | Negative | 9 | 10 | 19 |
| | | Positive | 3 | 13 | 16 |
| | | Total | 12 | 23 | 35 |
| Total | US | Negative | 23 | 11 | 34 |
| | | Positive | 6 | 13 | 19 |
| | | Total | 29 | 24 | 53 |

## Discussion

In the current study out of n=53 patients studied, 57% (n=30) presented with young/uncontrolled/resistant/ accelerated hypertension, 33% (n=18) are known atherosclerotic disease patients and 9% (n=5) are cases of peripheral arterial disease/carotid disease/coronary artery disease. In the study population, n=10 (19%) are grouped under the normal category as no pathology is detected and n=43(81%) are grouped under abnormal category if they are having any kind of pathology (like stenosis, atherosclerosis, vasculitis, accessory renal artery, etc). Hansen KJ et al; [6] found the overall prevalence rate of RVD was 6.8%. Among the n=57 patients with RVD, n=50 (88%) had unilateral disease and seven (12%) had bilateral disease. Seven cases were seen of renal artery occlusion, including one case with contralateral renal artery stenosis. The mean ages of patients with and without RVD were 78.7 ± 5.7 years and 77.1 ± 4.9 years (P =0.018). In the present study, we found the highest number of patients are of the female population (n=28) when compared to males (n=25), the second-highest age group cohort is (61-70 years) who are found to have atherosclerotic renal artery disease of mean age group-68 years. Neymark E et al; [7] in their study found Renovascular abnormalities in the dictated reports in n=78 patients (10.9%). The most common causes were fibromuscular dysplasia and atherosclerosis. In three patients, no significant abnormality was seen at the retrospective review. In the present study also the most common abnormality identified in atherosclerotic disease followed by Takayasu's arteritis. Anatomical variants are also noted like accessory renal arteries which will have therapeutic significance. Kjell Tullus et al; [8] conducted a study to evaluate the etiopathogenesis and the course of RVD is different between children and adults. The dominating diagnosis in adults is atherosclerosis, mostly affecting the main renal arteries. The diagnostic spectrum is different in children, with the most common reported diagnosis being fibromuscular dysplasia (FMD), although it is unusual for histological confirmation to be obtained and the diagnosis is usually made by exclusion. In some countries, Takayasu's disease is more common than is FMD. In the present study Colour Doppler, the US failed to detect all accessory renal arteries. MRA did not detect stenotic accessory renal arteries, depicted only 6/16 accessory renal arteries, but failed two main renal arteries. The overall sensitivity, specificity, and positive and negative predictive accuracy were 68%, 95%, 68.57%, and 88.29%, respectively, for color Doppler the US; Sensitivity: 84.84%; Specificity: 97.75%; Positive Predictive Value: 93.33%; Negative Predictive Value: 94.56% For NC-MRA. The present study is in agreement with the study conducted by C. Rountas et al; [9] in the concept of an imaging algorithm including US doppler as a screening test and CTA or MRA as the second step- procedure. Leiner, T et al; [10] analyzed several published literatures works to provide an overview of noninvasive techniques such as MR angiography, CT angiography, and color-aided duplex ultrasonography techniques as promising alternatives that also allow functional characterization of RAS and discuss their relative merits and shortcomings. Analysis of high-quality studies shows that both MR and CT angiography are significantly more accurate for the diagnosis of at least 50% atherosclerotic RAS than ultrasonographic techniques. The primary strength of ultrasonography at present is its suggested ability to predict functional recovery based on pre-interventional resistance index measurements. The present study is in concordance with the study done by Leiner, T et al; [10] that both MR and CT angiography are significantly more accurate for the diagnosis of at least 50% atherosclerotic RAS than ultrasonographic techniques.

## Conclusion

The results of present study concluded that ultrasound renal Doppler and non-contrast magnetic resonance renal angiography can be used as initial screening modalities to evaluate renal artery stenosis, with NC-MRA having slightly high sensitivity and specificity, US renal Doppler allowing for functional analysis and CTA is the best modality of choice to characterize the pathology and to visualize variant anatomy when compared with ultrasound renal Doppler and non-contrast MRA.

***Conflict of Interest:*** *None declared*
***Source of Support:*** *Nil*
***Ethical Permission:*** *Obtained*

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