

# Role of Physical and Clinical Parameters in Diagnosing Renal Artery Stenosis by Scintigraphy

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**Abstract**— Renovascular hypertension (RVH) is likely to be curable hypertension mostly caused by renal artery stenosis [1]. Captopril renal scintigraphy is a noninvasive cost effective method of demonstrating RVH. Early diagnosis and treatment of RVH result in avoidance of parenchymal damage and there are no side effects of captopril renography were observed [2,3]. The purpose of this study is to assess the clinical usefulness and the role of captopril in diagnosing the patients who have renal artery stenosis (RAS) by scintigraphy. Thirty patients with highly suspected renal artery stenosis underwent two protocols baseline and captopril scintigraphy using 111MBq of <sup>99m</sup>Tc-MAG3. From (25-50) mg oral dose of captopril (angiotensin – converting enzyme inhibitor) was given one hour before captopril study. The renographic criteria were established to diagnose renal artery stenosis based on presence of captopril that made changes in the curve of renogram. RAS was detected in ten patients confirmed on renal angiography and captopril scintigraphy was positive for RAS in nine of these with sensitivity 90%. The other twenty cases were negative for RAS by captopril study. The criteria which were established for diagnosing RAS are prolongation of Tmax with p-value ( $p=0.009$ ) as the mean  $\pm$  SD min ( $5.58 \pm 2.23$ ) min. at basal study and ( $12.6 \pm 6.05$ ) min. at captopril study or presence of parenchymal retention recorded together with prolonged  $T_{1/2}$  after captopril administration. Parenchymal retention (activity retained in the cortex) is an important criterion that represent high probability of RAS. Mismatching between time to maximum count rate or parenchymal retention at both basal and captopril study is a highly suggestive cause of significant RAS that sure sign for renovascular hypertension. Angiography is recommended for those who diagnosed to have RVH.

**Index Terms**— captopril renal scintigraphy, renovascular hypertension, renal artery stenosis

## 1 INTRODUCTION

Renovascular hypertension (RVH) is an arterial hypertension in association with renal artery stenosis and hypertension. It promotes when the morphological abnormality is repaired [4, 5,6]. The renovascular disease (RVD) represents 3-5% of patients with hypertension. As a renovascular hypertension is amenable to treatment, a lot of efforts dedicated to detect and treat renal artery stenosis [7]. The majority of hypertensive patients having high blood pressure due to unknown or essential origin. However the hypertensive patients with known or identifiable cause known as secondary hypertension which account no more than about 10% of all hypertensives [8].RVH is a form of secondary hypertension [9]. Due to presence of renal artery stenosis leads to hypoperfusion which stimulates renin angiotensin system that induce RVH which progress to elevate blood pressure.

creased levels of renin lead to production of angiotensin II, which induce vasoconstriction, and increased level of aldosterone which make narrowing of the blood vessels as well as leads to sodium and water retention. These progressions eventually result in hypertension. Clinical manifestations refer to which patients have an intermediate or high risk of renovascular hypertension [10]. Atherosclerotic renal artery and fibromuscular dysplasia are the two most diseases that affect the renal arteries , And it is found that atherosclerotic renal artery disease influences more than 90% of cases that is the most frequent cause of secondary hypertension [11,12] .

The early reports for adults demonstrated that captopril scintigraphy was a successful examination imaging test with sensitivity of 83-93 % for detecting the renovascular disease [13,14].

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Renal scintigraphy with  $^{99m}\text{Tc}$ -diethylenetriamine (DTPA) and without captopril had less specificity and sensitivity in detecting renal artery stenosis. However, in combination of both of them, specificity and sensitivity had been improved significantly [1]. Renal scintigraphic study assesses the renal function and perfusion. Most isotopic studies were done in adults with an angiotensin converting Enzyme inhibitor (ACEI), that provides sensitivity of 60%-100% and specificity of 70%-100% for finding of renovascular disease [15,16,17,18,19].

The aim of this study is to estimate role of scintigraphy using captopril in diagnosing RAS and the abnormalities seen in the renogram curves as well as analytic data including physical parameter.

## 2 SUBJECT AND METHOD

### 2.1 subject

Forty four patients seen in Urology and Nephrology center at Mansoura University. Thirty of them with high suspicious renal artery stenosis were studied at nuclear medicine unit. Two days protocol were performed, Captopril scintigraphy was done followed by baseline study five days later.

### 2.2 Preparation of Patient:

Patient must be given an appropriate amount of water before the start the diagnosis (10 ml/kg of body weight) and shouldn't eat a solid meal 6hs before the diagnosis, as the food with the gastrointestinal tract decrease captopril absorption. Any antihypertensive drugs from ACEI group should be stopped 2 days prior to the study.

### 2.3 Captopril renal scintigraphy

Captopril was taken orally (25-50 mg) one hour before the study. Patient lies supine in position with the detector beneath. From 3-5 mCi of technetium- $^{99m}\text{M}$  Mercaptoacetyltryglycine ( $^{99m}\text{Tc}$ -MAG) were injected intravenously bolus injection with acquisition one frame/second for sixty seconds followed by one frame every twenty seconds for another nineteen minute with total study twenty minutes in the dynamic mode. If captopril study results are suggested of RVH basal study (without captopril) is done five days later however, if these results are normal no need for further studies.

The two studies were performed using the gamma camera (Philips bright view, USA) with a low energy all purposes collimator beneath the patient, kidneys and bladder should be included so, a large field of view is preferred. Region of interest (ROI) was taken for both kidneys to generate reno-

gram curves with analytic data that contains Time to maximum count rate (Tmax) and half time (T1/2). Tmax defined as time from injection to the maximum time of count rate and half time is the time from maximum activity to the time of half maximum count rate [20]. Scintigraphic data were recorded on a computer connected with gamma camera starting immediately after injection. Statistical analysis calculated by using SPSS software.

## 3 Results

Among thirty patients with high suspicion of renal artery stenosis. Scintigraphic diagnosis of RVH was found in nine patients where parenchymal retention of tracer was recorded together with prolonged T1/2 (normal T1/2 < 10 minutes) and Tmax in captopril study. In these cases basal studies were done five days following captopril study; mismatching results in the form of absence of tracer parenchymal retention with good drainage confirms diagnosis of RVH scintigraphically. Captopril renal study shows true positive diagnosis in nine patients (6 male & 3 female with age ranged between 15 & 32 years) and false negative diagnose in another one. Angiography was done in all suspected ten patients to have RAS and is taken as a gold standard. Functional RVH can be diagnosed scintigraphically where there is severe parenchymal retention of the tracer together with prolonged T1/2 minute at captopril study with less degree of parenchymal retention of the tracer and reduction of the T1/2 value or normal renogram curves at basal study.

In patient with significant RAS the (mean  $\pm$  SD) value of Tmax (5.58  $\pm$  2.23) min. at basal study increased to (12.6  $\pm$  6.05) min. at captopril study and the value of T1/2 (or parenchymal retention) ranged between (12.1 & 103.3 min) at captopril study while in case of basal study has a value ranged between (5.25 & 19.26) min. So there is a marked change in Tmax and T1/2 between baseline and captopril study, worsening of the renogram curve and decrease of urinary excretion as shown in the figure (1, 2).

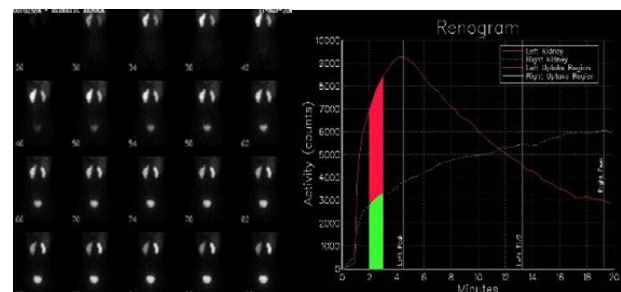


Figure1: Captopril scintigraphic study

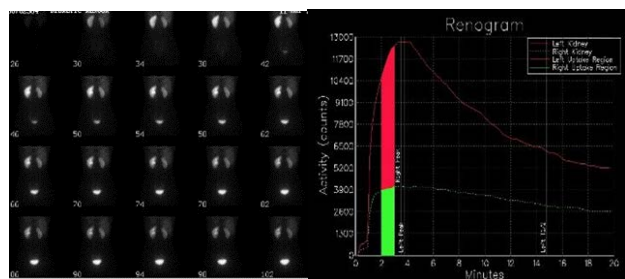


Figure 2: Basal scintigraphic study

At both studies, the right kidney showed reduction in perfusion, tracer uptake and delayed excretion due to parenchymal retention of tracer (more prominent at captopril study). The right renogram curve at basal study showed flattened peak with mild descent in the third phase, however in captopril study the curve appeared rising like to obstructed curve due to severe parenchymal retention however, the left kidney handles normally at both studies.

In the false negative case in spite of relative anatomical narrowing noted in other radiological modalities there is no parenchymal retention of the tracer and neither significant reduction in tracer uptake at captopril study. In these case close follow up of the renal function must be done with conservative treatment as shown in figure (3). The other twenty cases were negative for RAS because they were normal at captopril study without any parenchymal retention of the tracer.

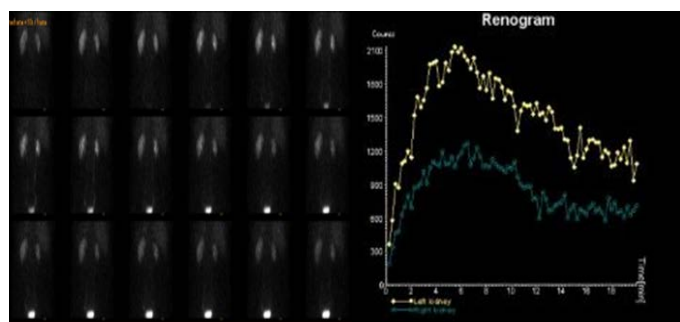


Figure3: captopril study

## 4 Discussion

ACE inhibitor renography is a method used for the detection of significant RAS functionally; not the detection of RAS anatomically [21,22] ACE-inhibition renogram interpreted as the presence of high probability for renovascular hypertension involves a high predictive value (90%) for existing renal artery stenosis and that the hypertension will be improved or cured

by revascularization.[23].

Renal artery stenosis can be detected and evaluated by Captopril renal scintigraphy as it is used to predict the Patient's prognosis out comes. So it is an ideal method for imaging examination. Renal scintigraphy has recently been used with different agents for diagnosing of renal artery stenosis. Majid M et al. (1983) found that the accuracy will be high in the diagnosis of RVH using captopril renal scintigraphy. Dondi M et al (1992) assess the prognostic value in renovascular hypertension by captopril scintigraphy and demonstrate that positive preoperative renal scintigraphic in high presence of hypertension curability of revascularization [24]. The function of magnetic resonance angiography (MRA) in the detection of renal artery stenosis is restricted without establishing of physiological significance [25]. Renal arteriography considerable as a gold standard, however it is invasive expensive, and can't distinguish between significant obstruction and incidental renal artery stenosis [2].

Today renal scintigraphy with ACEI has high sensitivity and specificity in the diagnosis of RVH [15, 16, 17, 18, 19]. The used of mercaptoacetyl triglycine (MAG3) or diethylenetriamine (DTPA) had no effect on the sensitivity of the examination [26]. As a result of using qualifying criterion of ACE inhibitor-induced changes between baseline and captopril scans to determine a positive test, the test has a specificity of at least 90% and therefore has a high positive predictive value [27, 28] Unilateral preservation for the tracer MAG3 or orthoiodohippurate (OIH) after administration of ACE inhibitor in the parenchyma indicate for renovascular hypertension with high probability (> 90%). It is calculated by measuring a change in the 20 mm / peak ratio of 0.15 or higher, a significantly prolonged flow time or a change in the form renogram grade (Fig. 1) [10].

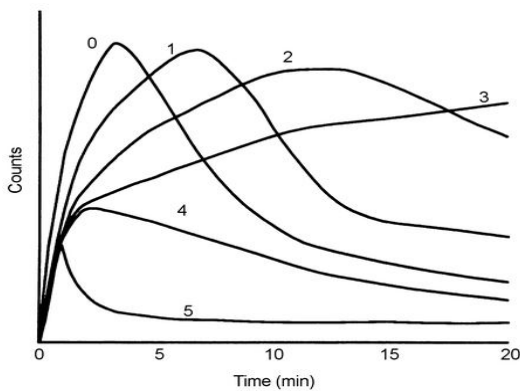


Figure 1: Prevalent renogram patterns utilized for visual interpretation of ACE inhibitor renography

Type zero, normal; type one, the time to maximum peak (Tmax) of  $> 5$  min and 20-min/maximum count ratio of  $> 0.3$  for background-subtracted  $^{131}\text{I}$ -OIH and  $^{99\text{m}}\text{Tc}$ -MAG3 figure; type two, more high delays in time to maximum peak and in parenchymal washout; type three, developing parenchymal accumulation (no washout was detected); type four, kidney failure pattern but with measuring of renal uptake; type five, kidney failure pattern represented in the form of blood background activity only [22].

In case of severe stenosis there is a delay or absent of the tracer excretion throughout twenty minutes of the observation time. The severity levels of stenosis depend on the parenchymal retention of tracer [1]. Renal angioplasty should be performed when estimated the renal function by captopril renography as it is a good method.

Thorsson O et al (2009) used captopril scintigraphy with Tc-MAG3 and a baseline study was recommended in patients with abnormal captopril study, which show that the patients with suspected RVH captopril renal scintigraphy is a very suitable and useful for them [29]. In Nally JV1, Barton DP. (2001) study reported that postcaptopril renography is a safe and noninvasive way to screening patients with hypertension. In the comparative studies of Elliott and Miralles and colleagues, captopril renography was a highly sensitive and specific imaging method than the test of captopril plasma renin activity for diagnosing and evaluation of the renovascular hypertension [30]. Taylor A. (2000) after using Angiotensin-converting enzyme inhibitor renography (captopril renography), found that it is the only screening test that represent the existence of renovascular hypertension (RVH). ACEI renography is the most appropriate method for the patients with stable renal function and patients with suspected RVH [28]. Andrew T. Taylor et al (2003) using ACEI renography with  $^{99\text{m}}\text{Tc}$ -MAG3 or  $^{123}\text{I}$ -OIH/ $^{123}\text{I}$ -hippuran as interpreted

the specific criteria for diagnosis of RVH are a prolongation of the Tmax at minimum 2-3 minute, delay in the excretion of the tracer after captopril administration by 2 min and unilateral retention of the tracer in the parenchyma as it is the most important criterion [22].

In the present study, showed that for severe or significant renovascular hypertension (RVH) there is a discrepancy or marked decrease between finding in captopril and basal studies in a form of prolongation of Tmax with ( $p=.009$ ) and presence of parenchymal retention of the tracer (prolonged T1/2) in captopril study compared with basal study with sensitivity of 90%. But for negative RAS there is no change in the renogram curve and the parameters mentioned above between two studies.

## 5 CONCLUSION

It is concluded that renal scintigraphy using captopril is a very sensitive method of detecting and diagnosing renovascular hypertension functionally and it gives important fundamental data in order to help in the diagnosing of the patients with suspected RAS.

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