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# Tc-99m-DTPA captopril renography in the detection of renovascular hypertension due to renal polar artery stenosis

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A 24-year-old man whose clinical features were suggestive of renovascular hypertension was referred for captopril renal scintigraphy. Captopril renal scintigraphy was positive for renovascular hypertension only when the left kidney was analyzed in 2 separate regions. Angiography confirmed severe stenosis (90%) in the upper branch of the left renal artery.

**Key words:** renal artery stenosis, renovascular hypertension, scintigraphy

## INTRODUCTION

CAPTOPRIL RENAL SCINTIGRAPHY is a cost effective way of demonstrating renovascular hypertension (RVH). Inhibition of the compensatory mechanism mediated by the angiotensin converting enzyme (ACE) system results in detoriation of glomerular filtration function after ACE inhibitor (captopril) administration, and can be assessed by renal scintigraphy.[1–4]

In addition to interpretation of the changes in renogram curve patterns and analysis of semiquantitative parameters, careful visual evaluation of the images is crucial.[2,4]

In the present report, we describe a patient who had polar artery stenosis of the left renal artery. The abnormality was reflected to the renogram only when the left kidney was analyzed in 2 regions.

## CASE REPORT

A 24-year-old man was suspected of having RVH. The index of suspicion for RVH was high in this patient due to his young age and uncontrollable hypertension (150/110 mmHg) for 3 years which had become more severe in the last year. He also had systolo-diastolic abdominal bruit on the left side.

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*Captopril renal scintigraphy for the evaluation of RVH was performed in the following way*

The patient was fasted for 4 hours in order to optimize captopril absorption. He was hydrated with 0.9% NaCl solution (10 mg/kg) by the intravenous (IV) route 1 hour prior to the tests. Tc-99m-DTPA (diethylenetriaminepentaacetic acid) was the radiopharmaceutical used.

The scintigraphic study involved 2 steps;

*1) Baseline renal scintigraphic study (BS)* Posterior images were acquired with a single headed gamma camera (Toshiba GCA 601 E) equipped with a LEGP collimator. 10 mCi (370 MBq) Tc-99m-DTPA was injected by the IV route followed by rapid acquisition in the dynamic mode (64 × 64 matrix, 1 frame/second, 64 frames; then 1 frame/15 seconds, 96 frames). Nine static images were obtained in a 256 by 256 matrix, each for 2 minutes.

*2) Captopril renal scintigraphy (CS)* He was given oral captopril (50 mg) 1 hour before the acquisition. The scintigraphic images of the kidneys were obtained as described above.

There were 2 days between the BS and CS.

Kidney size, shape, tracer uptake and renal functions in BS and CS were evaluated by two experienced nuclear physicians.

For semiquantitative analysis, regions of interest (ROI) were drawn over the kidneys excluding the renal pelvis. Time-activity curves were generated after background substraction. Tmax and GFR values, and renal indices were determined with computer analysis from renogram curves for each kidney.

In Tc-99m-DTPA BS and CS the right kidney had

**Table 1** Tmax and GFR values in baseline and captopril scintigraphic studies

| | Right kidney | | Left kidney | |
|---|---|---|---|---|
| | Baseline Scintigraphy | Captopril Scintigraphy | Baseline Scintigraphy | Captopril Scintigraphy |
| Tmax (min) | 3.30 | 3.30 | 3.05 | 3.05 |
| GFR (ml/min) | 47 | 49 | 28 | 29 |

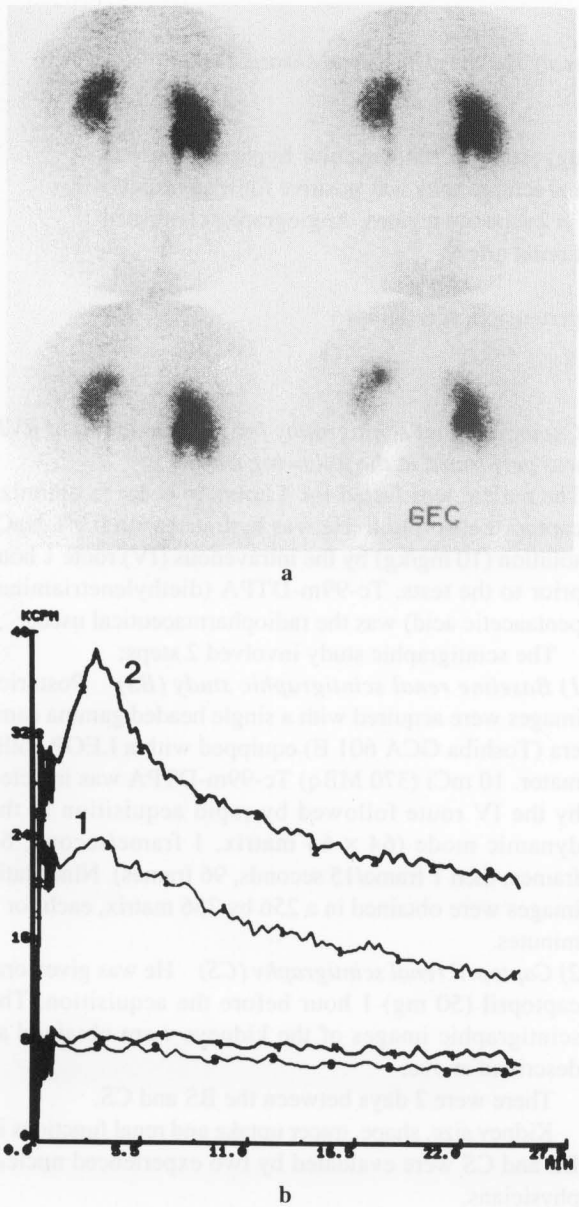


**Fig. 1** Baseline renal scintigraphic study of the patient. a) Posterior images show a small left kidney. The images obtained at 15, 18, 23, and 35 minutes in the clockwise order starting from upper left are shown. b) Baseline renograms (curve ≠ 1: left, curve ≠ 2: right). Right kidney curve displays normal function. Left kidney is smaller with a flattened renogram curve and displays hypofunction due to its smaller size.

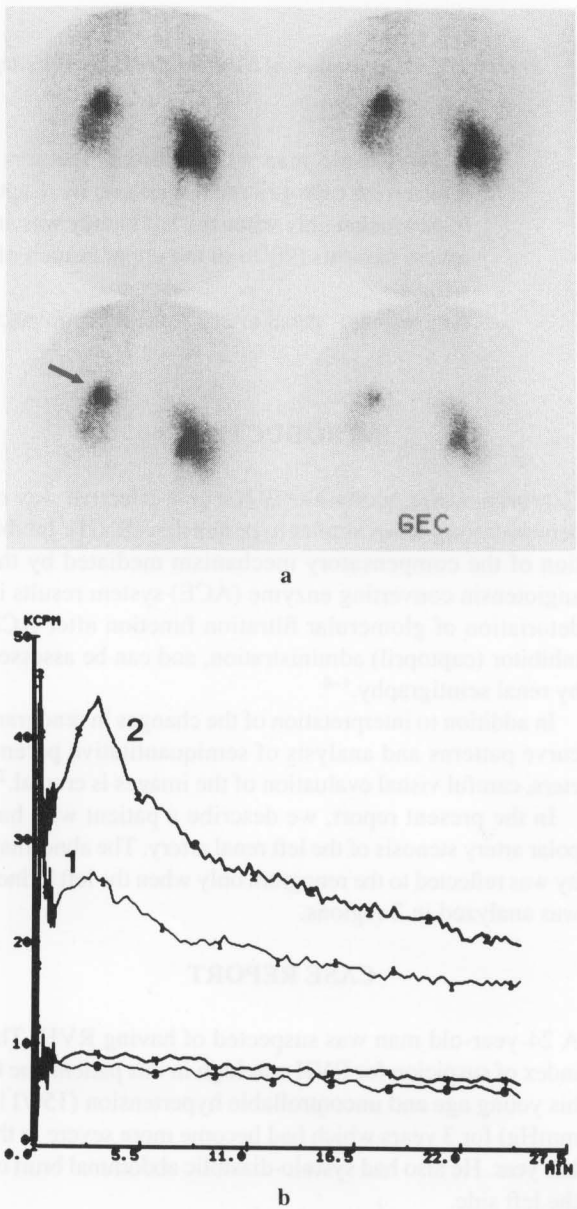


**Fig. 2** Captopril renal scintigraphy of the patient. a) The images which were obtained at 15, 18, 23, and 35 minutes in the clockwise order starting from the upper left are illustrated. Retention of radioactivity is seen in the upper pole of the left kidney (arrow). b) Renograms (curve ≠ 1: left, curve ≠ 2: right) which show no difference from the baseline curves are displayed.

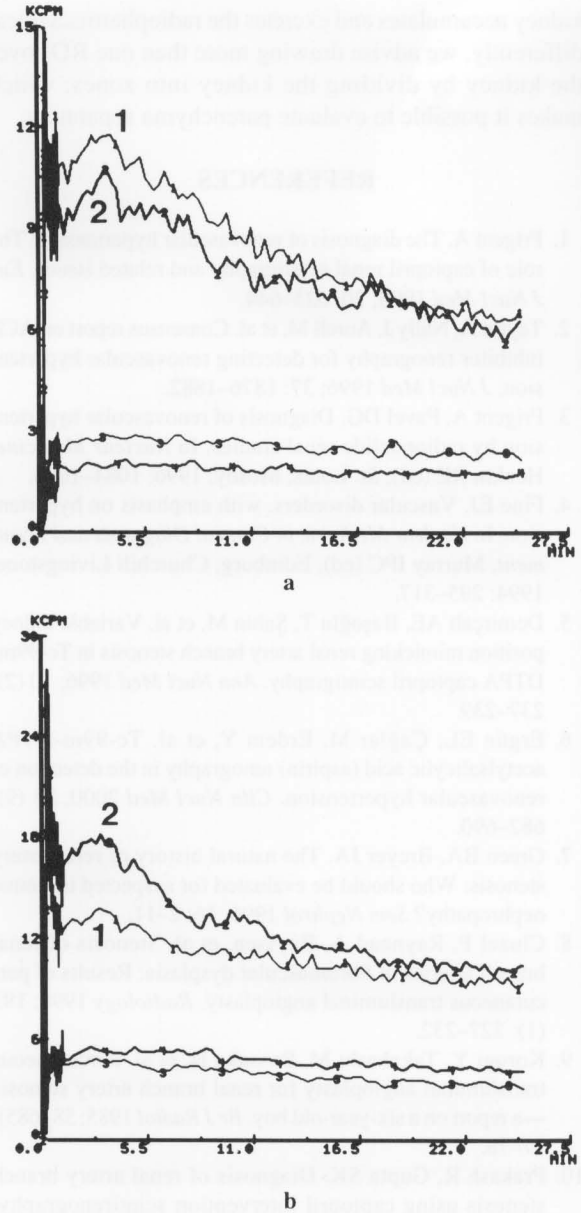


**Fig. 3** Renograms of the upper (curve ≠ 1) and lower (curve ≠ 2) poles of the left kidney show deterioration in the upper curve pattern on captopril renal scintigraphy: a) Baseline renal scintigraphic study. b) Captopril renal scintigraphy.

normal perfusion, concentration and excretion of the radiopharmaceutical. The left kidney was smaller, and so was the amplitude of the renogram curve. The Tmax and GFR values are mentioned in Table 1, but on careful examination we noticed that there was some retention of activity in the upper pole of the left kidney on CS (Figs. 1, 2).

When separate 2 ROIs were drawn over the left kidney (on the upper and lower poles) both on the BS and CS, we observed that the renogram of the upper pole of the left kidney was deteriorated after captopril administration (Fig. 3) suggesting polar renal artery stenosis in the upper

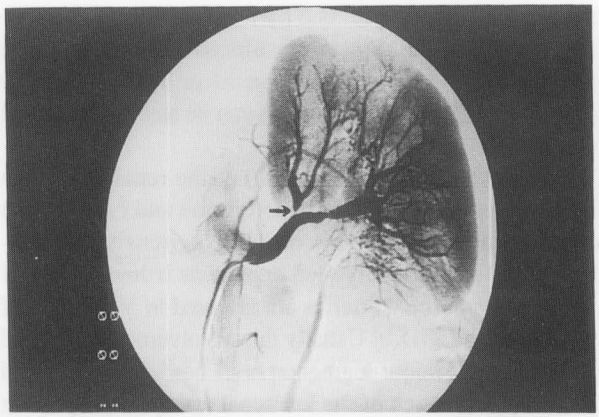

**Fig. 4** Renal arteriography of the patient shows 90% stenosis at the upper branch of the left renal artery (arrow).

pole. Differential function which represents the percentage of radiotracer taken up by the upper and lower poles of the left kidney and, in essence, the percent functional mass of each pole of the left kidney, was calculated for each scintigraphic study. The differential function was obtained by using the uptake counts after the flow phase but before the radioactive tracer arrived in the collecting system (extraction phase), between the 1st and 3rd minutes. It was calculated by dividing the counts for one pole of the kidney by the counts for the whole kidney after background substraction. On BS, differential functions of the upper and lower portions of the kidney were 52% and 48%, respectively. Differential functions of the upper and lower zones were found to be 41% and 59%, respectively on CS, which was suggestive of RVH.

The patient had renal arteriography after the scintigraphic examination and 90% stenosis was found in the upper branch of the left renal artery (Fig. 4).

## DISCUSSION

Despite the relative low percentage of 1% and 4% in the general hypertensive population, RVH is caused by unilateral and bilateral stenosis of the main renal artery, branch artery stenosis, whole kidney or focal renal infarction, aneurysms and arteriovenous malformations.[5]

The diagnostic tests for RVH include Doppler ultrasonography and magnetic resonance angiography, which both provide accurate measurements of renal blood flow but magnetic resonance angiography is expensive, and the success of Doppler ultrasonography depends on the operator. Peripheral and renal vein measurements generally add little information to the diagnosis of RVH. Renal arteriography is accepted as the gold standard, but it is invasive, costly, and does not hemodynamically differentiate significant obstruction (RVH) from incidental renal artery stenosis. Captopril renal scintigraphy is a cost effective and non invasive way of demonstrating renovascular hypertension (RVH). The inhibition of the compen-

satory mechanism mediated by the angiotensin converting enzyme (ACE) system results in detoriation of the glomerular filtration function after ACE inhibitor (captopril) administration which can be assessed by renal scintigraphy.[6]

Fibromuscular disease (FMD) of the renal artery is a fairly uncommon cause of hypertension and can occur in approximately 0.14%–2% of the hypertensive population. FMD is commonly seen in patients below the age of 35. Segmental renal arteries are affected in 30%–56% of patients with FMD.[7,8] Usually this involvement is located at the origin of major segmental branches[9] as we observed in the upper branch of the left renal artery in the present case.

Diagnosis of polar renal artery stenosis in a patient was observed by Tc-99m-DTPA CS as a dramatic reduction in renal perfusion and cortical uptake in the upper and midpoles of the affected kidney, and the presence of renal artery branch stenosis was confirmed on renal angiography in a report by Prakash and Gupta.[10] A reduction in relative uptake (greater than 10%) after captopril intervention indicates high probability of RVH while using Tc-99m-DTPA in CS. Parenchymal retention after captopril intervention compared to the baseline study is uncommon with Tc-99m-DTPA, but when present it indicates a high probability (> 90%) for RVH.[2] In concordance with this finding, in the case presented above, we observed parenchymal retention of Tc-99m-DTPA in the upper pole of the left kidney as seen on the 23rd min image (Fig. 2b) after captopril administration. This finding led us to think of a possible polar artery stenosis in the left kidney upper pole, and angiography confirmed our finding (Fig. 4).

In our patient, positive scintigraphic results were obtained for RVH only when we drew 2 ROIs, the upper and lower poles, on the kidney separately. The patient was later found to have severe stenosis (90%) of the upper branch of the left renal artery on angiography.

If polar artery stenosis is suspected, or if one pole of the kidney accumulates and excretes the radiopharmaceutical differently, we advise drawing more than one ROI over the kidney by dividing the kidney into zones, which makes it possible to evaluate parenchyma separately.

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