Diagnostic Use of Angiotensin Converting Enzyme (ACE)-Inhibited Renal Scintigraphy in the Identification of Selective Renal Artery Stenosis in the Presence of Multiple Renal Arteries: A Case Report

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In patients with renovascular hypertension, it is unknown whether the angiotensin converting enzyme- (ACE) inhibited renal scan will identify stenosis of a segmental branch of a single renal artery or of an accessory artery where multiple renal arteries are present. Since multiple renal arteries may be present in approximately 25% of all individuals, it will be important to establish whether the ACE-inhibited renal scan is useful in this population. We report a case of stenosis involving a renal artery in a patient with multiple renal arteries, successfully identified by ACE-inhibited renal scintigraphy.

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Renovascular hypertension (RVH), which accounts for only 5% or less of all cases of hypertension, is nonetheless the most common form of secondary hypertension (*1*). The disease is most often caused by activation of the renin-angiotensin system due to renal artery stenosis (*RAS*). The identification of those patients with RVH is important since the disease can often be cured or significantly improved by surgery or angioplasty (*2,3*).

Previously, the diagnosis of RVH depended on the selective sampling of renal vein levels of renin and on the visualization of renal artery lesions by angiography (*4*). In recent years, radionuclide renal scintigraphy has been shown to be a useful screening test for RVH (*5–10*). Renal scans are performed both before and after the administration of an angiotensin converting enzyme (ACE) inhibitor, such as Captopril. The ACE inhibitor blocks formation of angiotensin II, resulting in a decrease in perfusion pressure and glomerular filtration in kidneys supplied by stenotic arteries. These changes in renal function have been observed following ACE inhibition in renal scans performed with technetium-99m- (^{99m}Tc) diethylenetriaminepentaacetic acid (DTPA), ^{99m}Tc-dimercaptosuccinic acid (DMSA), and iodine-131 (^{131}I) or iodine-123-hippurate (HIP).

In patients with RVH, it is unknown whether the ACE-inhibited renal scan will identify stenosis of a branch of a single renal artery or of an accessory artery in a kidney supplied by multiple renal arteries. Since multiple renal arteries may be present in approximately 25% of subjects, it will be important to establish whether the ACE-inhibited renal scan is useful in this population. We present a case of stenosis involving a renal artery in a patient with multiple renal arteries, successfully identified by ACE-inhibited renal scintigraphy.

CASE REPORT

A 50-yr-old white female was admitted to the hospital with multiple medical problems, including poorly controlled hypertension, advanced atherosclerotic vascular disease, and an abdominal aortic aneurysm. The physical exam was remarkable for diminished pulses in the lower extremities and the presence of bruits over both posterior flanks. Her blood pressure on admission was 164/92 mm Hg, despite treatment with Minoxidil and Nifedipine. Pertinent laboratory data included: serum sodium 136 mEq/l (normal), serum glucose 87 mg/dl (normal), blood urea nitrogen 31 mg/dl (normal), serum creatinine 1.1 mg/dl (normal). The urinalysis was normal.

Radionuclide renal scintigraphy was performed both with and without ACE-inhibition. For both studies, the patient received 10 mCi of ^{99m}TC-DTPA and 300 Ci ^{131}I-HIP. Using

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a parallel-hole, low energy, high sensitivity collimator, 2-sec images of the kidneys in the posterior projection were acquired for 2 min following the intravenous bolus injection of the DTPA, followed by serial 1 min static images for 20 min and a delayed static image at 90 min. Following intravenous injection of ^{131}I-HIP, 3-min images were obtained for 30 min with a medium energy collimator. Time-activity curves for both the DTPA and HIP data were generated. Split renal function was measured as differential uptake during the 2–3 min interval following visual arrival of DTPA in the kidneys. The ACE-inhibited renal scan was performed 24 hr after the standard renal scan. Oral administration of 50 mg of captopril was given 45 min prior to injection of the DTPA, resulting in a decrease in the patient's blood pressure from 175/85 to 120/70 mm Hg. Images from both the standard and ACE-inhibited renal scans are shown in Figure 1 (static images, DTPA) and Figure 2 (HIP images). Four days after the ACE-inhibited renal scans, the patient underwent aortographic evaluation of the renal arteries. A representative image from the digital subtraction aortogram is shown in Figure 3.

RESULTS

Dynamic (angiographic) images, static images, and time-activity curves of the standard (pre-captopril) DTPA scan demonstrated delayed and diminished blood flow and diminished delayed uptake of DTPA in a small left kidney, with normal flow and uptake in the right kidney. Tortuosity and pooling of DTPA in the abdominal aorta and poor bilateral visualization of the iliac arteries were consistent with the presence of an abdominal aortic aneurysm. On the pre-captopril HIP scan, uptake and excretion from the left kidney were diminished when compared to the right. These findings suggested the possibility of renal artery stenosis involving the left kidney.

The ACE-inhibited renal scan produced striking changes in both kidneys, when compared to the pre-captopril scan. Blood flow and uptake of DTPA in the small left kidney was markedly diminished. In the right kidney, the ACE-inhibited ^{99m}TC-DTPA renal scan demonstrated markedly diminished blood flow and uptake of the pharmaceutical only in the upper pole, with preservation of flow and uptake of DTPA in the lower pole. The ACE-inhibited HIP scan demonstrated a global decrease in excretion, as shown by progressive accumulation of activity in both kidneys. No definite intrarenal differences were appreciated in the right kidney on the HIP scan following ACE inhibition, either by visual analysis or time-activity curves. Overall, the scans suggested renin-mediated hypertension, with severe stenosis of the left renal artery and stenosis of either an upper pole renal artery (in the presence of multiple arteries) or of a subsegmental branch in the right kidney. Lack of right intrarenal variation in uptake or excretion on the HIP scan following captopril may have been due to the limited resolution with ^{131}I, when compared to ^{99m}Tc.

The contrast aortogram demonstrated severe atherosclerotic changes of the abdominal aorta and iliac arteries. The small left kidney was supplied by a single renal artery which had a high-grade proximal stenosis (>95% of the diameter). The right kidney was normal in size and was supplied by two renal arteries; the more cephalad of these supplied the upper pole of the kidney and had a high grade proximal stenosis (greater than 90% of the diameter). The lower pole renal artery was angiographically normal. The patient refused surgery or further intervention with respect to her renal artery stenoses.

DISCUSSION

Multiple renal arteries are among the most common variants of renal anatomy. Although more often present in malrotated or ectopic kidneys, the incidence of mul-

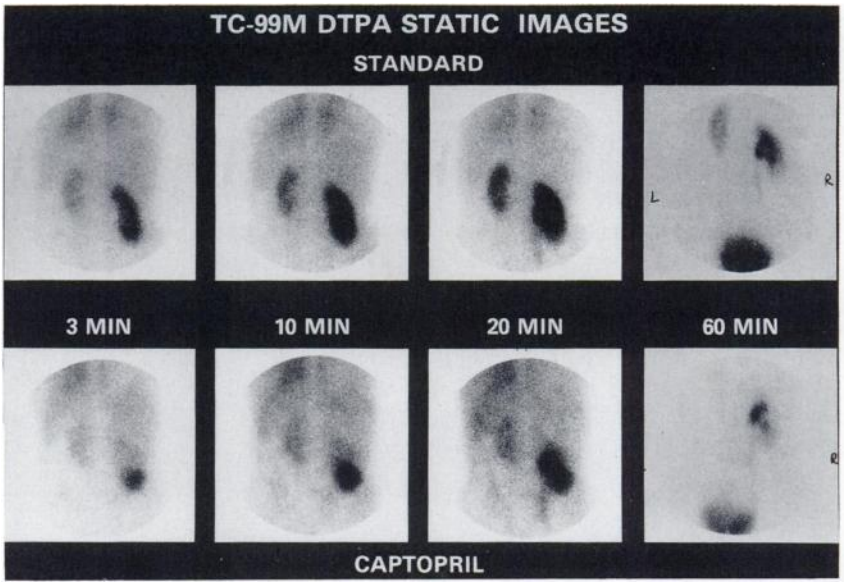


FIGURE 1
Technetium-99m-DTPA static images. Standard (pre-Captopril) static delayed images of the kidneys in the posterior projection at 3, 10, 20, and 60 min following administration of ^{99m}Tc-DTPA demonstrate a small left kidney with diminished concentration of DTPA when compared to a normal-appearing right kidney. Similar static images following ACE-inhibition reveal even more severely diminished uptake of the pharmaceutical in the left kidney as well as in the upper pole of the right kidney. The lower pole of the right kidney demonstrates normal concentration of DTPA on static images of both the pre- and post-Captopril studies.

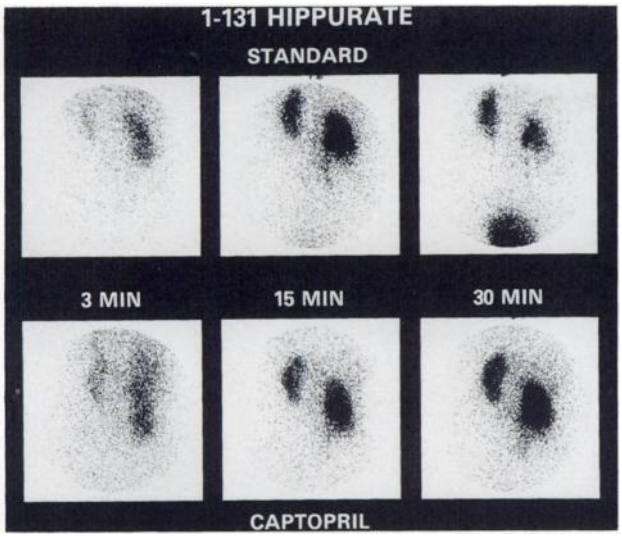


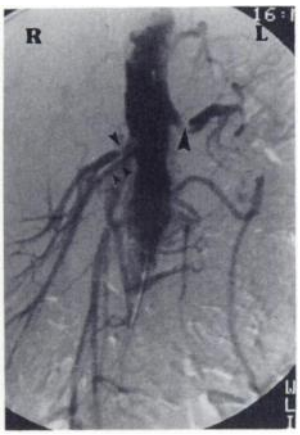
FIGURE 2
Iodine-131-hippurate. The HIP portion of the pre-Captopril renal scan in the posterior projection demonstrates delayed and diminished uptake of the radiopharmaceutical in the left kidney when compared to the right. This finding is more obvious during the first 15 min of the study. The ACE-inhibited renal scan demonstrates a global decrease in excretion of HIP by both kidneys when compared to the standard (pre-Captopril) scan. The lack of intrarenal variation in uptake or excretion of HIP by the right kidney following ACE-inhibition may be due to the limited resolution with ^{131}I, when compared to ^{99m}TC.

tiple renal arteries in orthotopic (normally-placed) kidneys has been estimated at 20%–27% in the angiographic literature (*11*). Of kidneys with multiple renal arteries, only 5% have more than two arteries (*12*). One dominant artery usually arises from the aorta at the normal level and supplies the anterior and dorsal intermediate portions of the kidney. Supplemental renal arteries can arise from the abdominal aorta, from iliac arteries, or, in rare cases, from mesenteric, celiac, lumbar or sacral arteries (*13*). Seventy-five percent of all supplemental renal arteries arise from the aorta just below the main renal artery and supply the lower pole of the kidney. This supplemental artery usually passes anterior to the uretopelvic junction, where it may cause obstruction and hydronephrosis (*13*).

The noninvasive detection of individual stenotic renal arteries in the presence of multiple arteries is likely to contribute greatly to the diagnostic evaluation of patients with suspected RVH. The angiographic identification of multiple renal arteries can be difficult. The supplementary vessels may be confused with overlying mesenteric or lumbar arteries. Therefore, a high index of suspicion for stenosis of supplemental vessels provided by the ACE-inhibited renal scan justifies a comprehensive search for these vessels at the time of angiography to include additional angiographic projections. These same principles would apply to the detection of stenoses in segmental branches of single renal arteries.

Based on the findings in this single patient with multiple renal arteries, the ACE-inhibited renal scan may be used successfully to identify a single stenotic vessel in patients with RVH and multiple renal arteries. Additional investigation is warranted to establish the efficacy of the ACE-inhibited renal scan in this population and for those in whom stenoses of segmental branches of single renal arteries exist.

FIGURE 3
A digital subtraction image in the anteroposterior orientation (the opposite orientation from the renal scans) from a contrast aortogram demonstrates severe atherosclerotic irregularity of abdominal aorta. The left kidney is supplied by a single renal artery, with a high-grade proximal stenosis of >95% of the diameter (large arrow). The right kidney is supplied by two renal arteries. The most cephalad of the two has a high-grade proximal stenosis of >90% of the diameter (medium arrow). The inferiormost of the two right renal arteries is angiographically normal (two small arrows).



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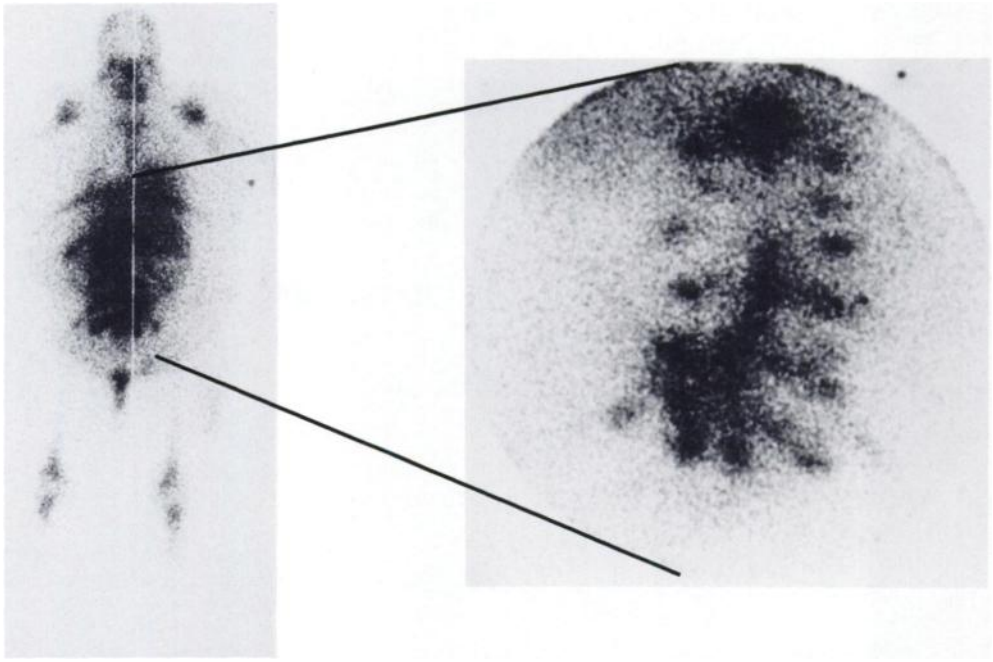

FIRST IMPRESSIONS

ACQUISITION INFORMATION:
A 37-yr-old obese female with fever and leukocytosis was referred for ^{67}Ga imaging to rule out abdominal abcess. The patient was 17 days status post-emergency laparotomy for acute abdomen, which had disclosed a very large pelvic abcess adherent to the uterus and ovaries. Deep fascial closure with drains and retention sutures had been placed. Gallium-67 imaging showed patchy diffuse activity in the abdomen with focal areas of activity at the suture sites. Probing and drainage of the abdomen demonstrated an abdominal wall abcess. The patient did well following drainage and antibiotic therapy.

TRACER:
10.59 mCi ^{67}Ga-citrate

ROUTE OF ADMINISTRATION:
Intravenous injection.

TIME AFTER INJECTION:
48 and 72 hours.

INSTRUMENTATION:
Gallium-67 spot and whole-body imaging.

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