Radioisotopic Renography
Diagnosis of Renal Arterial Disease in Hypertensive Patients

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The feasibility of surgical relief of hypertension associated with renal artery stenosis has been clearly established.\(^1\-^5\) In the preoperative diagnosis of secondary hypertension of this type, function studies and arteriography have been the only available procedures. However, renal arteriography and studies of separated renal functions after cystoscopic examination and bilateral ureteral catheterization are time-consuming and expensive, they require hospitalization, and they are discomforting and also somewhat hazardous for the patient. It is not possible in our practice to undertake such studies in all patients with hypertension whom we might consider potential surgical candidates. As for the use of urographic technics alone, they have not proved satisfactory for screening hypertensive patients for evidence of renal artery disease.\(^6\) The need for a diagnostic procedure that would permit the accurate screening of large numbers of hypertensive patients caused us to undertake a critical appraisal of the isotope renogram previously described by Taplin and associates.\(^7\) Our criteria for the selection of patients for study have been previously described.\(^8\)

**Methods**

Isotope renograms were recorded in 94 patients who were under clinical investigation because of hypertension of unknown etiology; the test medium was sodium ortho-iodohippurate (Hippuran) labeled with radioactive iodine (\(I^{131}\)).\(^9\) All patients underwent a complete general physical examination and specific examination of the optic fundus. Laboratory studies of urine and blood, roentgen examination of the chest, and electrocardiograms were also obtained as clinically indicated. Excretory urography was done in all patients. Renal arteriography by the translumbar or percutaneous transfemoral retrograde technic was performed in 53 patients, and separated renal function studies after cystoscopy and bilateral ureteral catheterization were done in 38 patients.

The radioisotope (\(I^{131}\)) renogram was obtained after the patients had abstained from food and water for a minimum of 8 hours; the procedure was usually repeated after a water load of approximately 1,000 ml. had been given. The purity of the radioactive reagent was determined by a chromatographic procedure.\(^9\) The equipment used is illustrated in figure 1. The standardized technic and the method of expression of data have been previously described.\(^10\) A normal isotope renogram is illustrated in figure 2. From the renograms, measurements of radioactivity were determined for points A (peak of initial deflection), B (peak activity), and C and D (20 and 30 minutes after injection), and the time after injection was determined for point B. The differences between these values for the two kidneys were calculated.

**Results**

Data recorded from the clinical history, physical examination, urographic studies, renal arteriograms, isotope renograms, and the final clinical diagnosis are summarized in table 1. Measurements of radioactivity for points A, B, C (20 minutes), and D (30 minutes), the time for point B, and the differences of these values between the two kidneys for the illustrated cases are recorded in table 2. Studies of renal function following cystoscopic examination and bilateral ureteral catheterization will be part of a subsequent report.

**Renal Artery Stenosis**

Thirty-seven of the 94 patients studied were found to have renal artery stenosis as demonstrated by arteriography or operation (one patient was sensitive to contrast medium and did not have arteriography, but he was proved to have medial fibromuscular stenosis at oper-
Table 1
Clinical Findings and Final Diagnosis in 94 Cases of Hypertension

<table>
<thead>
<tr>
<th>Number of patients</th>
<th>Atherosclerotic</th>
<th>Fibrous and fibromuscular</th>
<th>Pyelonephritis</th>
<th>Miscellaneous*</th>
<th>Essential hypertension</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Average age, yr.)</td>
<td>20</td>
<td>17</td>
<td>10</td>
<td>3</td>
<td>44</td>
</tr>
<tr>
<td>Known duration of</td>
<td>8</td>
<td>7</td>
<td>0</td>
<td>0</td>
<td>9</td>
</tr>
<tr>
<td>1 yr. or less</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Funduscopic evidence of accelerated hypertension (Keith-Wagener-Barker)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group 3</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>Group 4</td>
<td>6</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Continuous bruit</td>
<td>2</td>
<td>15</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Urogram: difference in renal size</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 1 cm.</td>
<td>6</td>
<td>4</td>
<td>0</td>
<td>3</td>
<td>35</td>
</tr>
<tr>
<td>1-2.5 cm.</td>
<td>5</td>
<td>11</td>
<td>2</td>
<td>0</td>
<td>9</td>
</tr>
<tr>
<td>&gt; 2.5 cm.</td>
<td>9</td>
<td>2</td>
<td>8</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Arteriogram Normal</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>15</td>
</tr>
<tr>
<td>Abnormal</td>
<td>20</td>
<td>15</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Renogram Normal</td>
<td>0</td>
<td>1†</td>
<td>0</td>
<td>2</td>
<td>41</td>
</tr>
<tr>
<td>Abnormal</td>
<td>20</td>
<td>16</td>
<td>10</td>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>

*One patient each with pheochromocytoma, primary aldosteronism, and nephrocalcinosis.
†By other criteria, this case was also abnormal.

Surgical confirmation of the clinical diagnosis was established in all of the 22 patients in this group who underwent operation.

Atherosclerotic Stenosis
Twenty patients had unilateral or bilateral stenosis of the renal arteries resulting from atheromatous lesions (table 1). The average age of these patients at the time of our examination was 54 years, with a range of 36 to 73 years. Eight patients (40 per cent) had known elevation of blood pressure for 1 year or less. The average duration was 6.2 years, with a range of 0 to 33 years. Eleven patients (55 per cent) had funduscopic evidence of accelerated hypertension (Keith-Wagener-Barker groups 3 or 4). In two patients, auscultation over the upper lateral portion of the abdomen revealed bruits that extended throughout systole and diastole. In almost all instances systolic bruits were detected over the upper part of the abdomen but were not necessarily more intense laterally or on the side with the stenosed or more severely stenosed renal artery. Measurement of the pole-to-pole diameter of the kidneys from the excretory urograms revealed that the difference between the two kidneys was less than 1 cm. in six patients (30 per cent), from 1 to 2.5 cm. in five (25 per cent), and more than 2.5 cm. in nine (45 per cent). A difference in the concentration of contrast medium within the calyceal system, which was usually greater within the smaller kidney, was frequently observed on x-ray films made 5 or 20 minutes after injection. The isotope renograms were abnormal in all 20 patients (table 1), and renal artery stenosis was confirmed by renal arteriography.

Fibromuscular Stenosis
Seventeen patients had unilateral or bilateral fibrous or fibromuscular stenosis of the renal arteries (table 1). The average age of these patients was 36 years, with a range of 18 to 59 years. The average duration of hypertension was 3.1 years, with a range of 2 months to 7 years. Seven patients (41 per
Equipment employed in renography. Probes of closely matched scintillation radioactivity-monitoring devices are placed over regions of kidneys of seated subject at point of maximal activity as determined by means of an audio signal that is switched at probe.

cent) had known elevation of blood pressure for 1 year or less. One patient had experienced an episode of right flank pain and gross hematuria 1 year prior to examination which was considered to have been consistent with a renal vascular accident. The patient was known to have been normotensive 6 months prior to the episode of pain but was and remained hypertensive thereafter. Five patients (29 per cent) had funduscopic evidence of accelerated hypertension. Fifteen of the 17 patients (88 per cent) were found to have a continuous bruit on auscultation of the upper lateral portion of the abdomen. The two patients who did not have bruits were found at operation to have posterior hilar renal infarcts and surrounding areas of renal ischemia. Measurement of the pole-to-pole diameter of the renal silhouettes from the urograms revealed a difference between the two kidneys of less than 1 cm. in four patients (23 per cent), of 1 to 2.5 cm. in 11 (65 per cent), and of more than 2.5 cm. in two patients (12 per cent). When differences were observed, the concentration of contrast medium was usually of greater intensity on the side with the stenosed or more severely stenosed renal artery. The isotope renogram was distinctly abnormal by the criteria described in 16 of the 17 patients. Arteriograms were made in 16 patients and were abnormal in 15. Stenosis in an aberrant artery, subsequently confirmed at operation, was not demonstrated in one patient by the arteriogram.

Pylonephritis

Ten of the 94 patients were found to have urographic evidence of chronic atrophic pylonephritis (table 1). Although the process was predominantly unilateral, two patients had evidence of significant bilateral disease. One patient had clinical evidence of renal insufficiency. The average age of the 10 patients was 46 years, with a range of 38 to 59 years. All patients had known of their hypertension for at least 2 years, and the duration ranged from 1 year to 20 years. Only one of the 10 patients had funduscopic evidence of accelerated hypertension and none had abdominal bruits. The diseased or more severely diseased kidney measured a minimum of 2 cm. less from pole to pole than did the contralateral kidney. Renal arteriography was not undertaken in any of these 10 patients. The isotope renogram was abnormal in all instances.

Other Types of Secondary Hypertension

Three patients were found to have uncom-
Table 2

Table of Values of Normal Renograms and of Illustrated Renograms

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Point A</th>
<th>Point B</th>
<th>Time R (20 min.)</th>
<th>Point C (30 min.)</th>
<th>Point D (30 min.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximal range and difference in normal subjects</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>.38 - .76</td>
<td>.20</td>
<td>.21</td>
<td>2.5 - 6.0</td>
<td>.10 - .40</td>
<td>.09 - .25</td>
</tr>
<tr>
<td>Normal</td>
<td>.60 .60</td>
<td>.00</td>
<td>.73 .75 .02</td>
<td>.30 .40 .00</td>
<td>.15 .15 .00</td>
</tr>
<tr>
<td>Renal arterial stenotic lesions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fig. 2</td>
<td>.39 .39</td>
<td>.00 .01</td>
<td>5.0 .11 .07</td>
<td>.44 .35 .09</td>
<td></td>
</tr>
<tr>
<td>Right renal artery stenosis</td>
<td>.38 .25</td>
<td>.31</td>
<td>.35 .30 .50</td>
<td>.18 .13 .05</td>
<td></td>
</tr>
<tr>
<td>Left renal artery stenosis</td>
<td>.47 .58</td>
<td>.15</td>
<td>1.0 .60 .50</td>
<td>.35 .20 .13</td>
<td></td>
</tr>
<tr>
<td>Right renal artery stenosis</td>
<td>.37 .35</td>
<td>.16</td>
<td>2.0 .35 .16</td>
<td>.41 .20 .21</td>
<td></td>
</tr>
<tr>
<td>Bilateral renal artery stenosis</td>
<td>.42 .40</td>
<td>.02</td>
<td>2.0 .60 .40</td>
<td>.42 .59 .17</td>
<td></td>
</tr>
<tr>
<td>Predominantly unilateral pyelonephritis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fig. 8 Right pyelonephritis</td>
<td>.30 .40</td>
<td>.10</td>
<td>1.5 .35 .50</td>
<td>.16 .24 .08</td>
<td></td>
</tr>
<tr>
<td>Right hydronephrosis and pyelonephritis</td>
<td>.58 .45</td>
<td>.13</td>
<td>8.5 .50 .35</td>
<td>.56 .25 .16</td>
<td></td>
</tr>
<tr>
<td>Essential hypertension</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fig. 10 Without azotemia</td>
<td>.48 .49</td>
<td>.01</td>
<td>4.0 .35 .05</td>
<td>.23 .22 .01</td>
<td></td>
</tr>
<tr>
<td>With azotemia</td>
<td>.31 .32</td>
<td>.01</td>
<td>3.0 .35 .05</td>
<td>.21 .21 .00</td>
<td></td>
</tr>
</tbody>
</table>

*Numbers in italics are abnormal values.
mon causes of secondary hypertension (table 1). One, a woman 24 years of age, had hypertension of 6 years' known duration, which was in an accelerated phase. A sympathectomy had been undertaken 5 years previously and had resulted in some improvement. Examination revealed no evidence of an abdominal bruit. The urographic, arteriographic, and renographic studies gave normal results. The patient had clinical evidence of primary aldosteronism.

One 38-year-old patient had clinical evidence of a pheochromocytoma. The urogram and isotope renogram were normal. A 28-year-old patient had diffuse nephrocalcinosis associated with renal tubular acidosis. The renal arteriogram was normal. The renogram was abnormal; the changes, however, were similar on the two sides.

Essential Hypertension

Forty-four of the 94 patients did not have evidence of secondary hypertension, and they were classified as having essential hypertension. The average age of these patients was 46 years with a range of 14 to 66 years. Nine (20 per cent) had known of their elevated blood pressure for 1 year or less; however, the average known duration was 5.6 years with a range of 0 to 19 years. Fourteen patients (32 per cent) had funduscopic evidence of accelerated hypertension. None of these patients had continuous bruits; low-frequency systolic bruits, however, were present over the abdominal aorta in some cases. In only nine patients was the difference in the pole-to-pole diameter of the two kidneys as much as 1 cm., and in only one of these was it more than 1.5 cm. (2 cm.). Renal arteriography was undertaken in 15 of these 44 patients; none had evidence of renal artery stenosis. Forty-one patients were found to have normal and three, abnormal isotope renograms.

Discussion

In this selected group of 94 patients, 50 were shown to have secondary hypertension; the patients were included in the study group particularly because of the strong clinical suspicion that this condition existed. The results of the isotope renogram were not made available to the clinician until the investigation of the individual case had been completed and a disposition determined. Results of isotope renography and other diagnostic studies were evaluated independently, and the various observations were then compared. The renogram was distinctly abnormal in 50 of the 94 patients studied. Three of the 50 patients who were demonstrated by other methods to have secondary hypertension had values on the renogram that were within the maximal range of normal, as determined in normotensive patients who did not have clinical or laboratory evidence of renal or renovascular disease. Although we regard the isotope renogram as a renal function test for the individual kidneys and do not propose that alterations of the renogram curve are distinctive for specific renal or renovascular disease states, certain observations regarding technic and types of curves as observed in this study seem worthy of more detailed discussion.

Procedure

Standardization of the methodology of the renogram has provided accurate reproducibility of the renogram curve in the individual patient. We consider it particularly important to utilize a standard dose of medium and a standard recording procedure. All patients receive 30 μc. of 113m-labeled hippurate. Hippurate is diluted in a sterile solution of 5 per cent dextrose to a concentration of about 150 to 250 μc./ml., so that a dose of 30 μc. is contained in about 0.12 to 0.2 ml.

The patient is studied after he has fasted (food and drink) for a minimum of 8 hours. After he has voided, the patient is comfortably seated and two matched counters are placed over the lumbar areas in the usual position for the kidneys. Injection is made into an antecubital vein. Placement of the counters is more accurately accomplished by the use of an audiomonitor to determine the region of maximal radioactivity for each kidney. We have not been able to accomplish accurate placement by roentgenologic determination of the position of the renal silhouette. Because
the renal mass may become displaced downward, placement of the counters is again confirmed by the audiomonitor during the procedure. If the region of maximal radioactivity has changed, the procedure is repeated with the probe in the newly determined position. After completion of the study, urine is obtained to determine the percentage of excretion of the injected dose for volume determination and for measurement of specific gravity. Should the patient not be in a state of antidiuresis, the procedure is repeated after further dehydration. A normal isotope renogram obtained in this manner is illustrated in figure 2; the values and maximal range of values and the differences between the two kidneys in a group of patients who did not have demonstrable disease are recorded in table 2. We have found it possible to alter the renogram markedly by an orally administered water load of 1,000 ml. or less, particularly in the presence of obstructive uropathy as well as in some patients with renal artery stenosis. In some instances it is possible to obscure the abnormal features of the renogram completely in this fashion.

Renal Artery Stenosis

Thirty-seven of the 94 patients were proved to have renal artery stenosis. Certain features of the clinical and laboratory data seem of interest and may prove helpful in the selection of patients for investigation. In contrast to patients with essential hypertension, in whom the average age in this series was 46 years, the patients with fibromuscular and atherosclerotic renal artery stenosis averaged about 36 and 54 years, respectively. Only one patient with atherosclerotic stenosis was less than 40 years of age. Forty-one per cent of the patients with stenotic lesions had known of their elevated blood pressure for not more than 1 year, and the average duration was 3.1 and 6.2 years for the patients with fibromuscular and atherosclerotic disease, respectively.

Only 20 per cent of the patients with essential hypertension had known elevation of blood pressure for 1 year or less, yet the average duration was 5.6 years. Of particular interest was the observation by our associates in the section of ophthalmology that a minimal degree or even absence of hypertensive sclerosis of the retinal arteries was common in patients with fibromuscular renal artery stenosis, compared with the findings in essential hypertension and atherosclerotic renal artery stenosis. Thirty-two per cent of the patients with essential hypertension and 43 per cent with renal artery stenosis (atherosclerotic, 55 per cent; fibromuscular, 29 per cent) had funduscopic evidence of accelerated hypertension (Keith-Wagener-Barker groups 3 and 4). Low-frequency systolic bruits were commonly observed over the abdominal aorta in patients with essential hypertension and renal artery stenosis; however, 46 per cent of the patients with renal artery stenosis had upper lateral abdominal bruits that extended throughout systole and diastole. We have previously noted the frequent occurrence of continuous bruits over the lateral portion of the abdomen in patients with fibromuscular stenosis of the renal arteries.

The urographic studies were not of great assistance in the investigation of patients with renal artery stenosis. In 27 per cent of the
patients subsequently proved to have unilateral or bilateral renal artery stenosis, the difference in the pole-to-pole diameter of the renal silhouettes was less than 1 cm. Patients with renal artery stenosis and apparent essential hypertension were frequently observed to have minor differences in the time of appearance and concentration of contrast medium in the calyceal systems. Only one patient had no evidence of contrast medium in the involved kidney on x-ray films obtained 5, 20, and 45 minutes after injection. We have subsequently obtained films at 2 and 3 minutes after injection and have more frequently demonstrated differences between the involved and uninvolved kidneys.

Arteriography was not done in one patient because of an urticarial reaction at the time of urographic study. This patient was shown to have the functional changes of renal artery stenosis, and the presence of that condition was confirmed at operation. In 35 of the remaining 36 patients, arteriography demonstrated renal artery stenosis (aberrant artery stenosis was not visualized in one patient).

The isotope renogram was distinctly abnormal in 36 of the 37 patients with renal artery stenosis. By other criteria, all were abnormal. Representative renograms are illustrated in figures 3 to 7. Eighteen of the 37 patients had bilateral disease. In the presence of unilateral disease the abnormalities were largely limited to the involved side, yet on rare occasions values higher than the normal range were also obtained for the uninvolved side (fig. 3 and table 2). In the presence of bilateral stenosis, the renogram made from the side of the more severely stenosed artery was abnormal; on some occasions the curves were abnormal bilaterally.

We do not propose to distinguish between atherosclerotic and fibromuscular stenosis on the basis of the renogram data. The curves may be similar; yet we have more commonly observed abnormally low values for points A and B in patients with atherosclerotic stenosis. There seems to be a definite correlation in patients who have low values in these parameters with clearance data, in which significant depression of the clearances of inulin and PAH are usually observed. Prolongation of the time of maximal radioactivity, time B, and high radioactivity values at 20 and 30 minutes after injection are commonly observed in patients with fibromuscular stenosis or atherosclerotic stenosis (or both) without severe decreases in the clearances of inulin and PAH. Similarly, patients with prolonged values for time B and increased radioactivity at 20 and 30 minutes usually have diminished

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**Figure 4**

Right and left renograms from patient with left renal artery stenosis (atherosclerotic). In this case, left curve is lower in all aspects than curve of uninvolved right side in contrast with curve in figure 3. Right curve is within normal limits.

**Figure 5**

Patient with severe fibromuscular disease of right renal artery. Abnormal aspects include a low peak accompanied by prolonged retention of medium and delay in peak time. Curve of uninvolved left side is within normal limits.
values for the urinary minute volume on the abnormal or more severely abnormal side. In all instances when the renogram was abnormal, the observations suggested that one side was more severely involved. One patient with bilateral fibromuscular renal artery stenosis had a renogram that revealed essentially equal function of the two kidneys. The values were slightly greater than the lower limits for normal subjects as established in our laboratory. It was not until later, when comparison was made with the clinical and other laboratory data, that we became aware of the necessity of studying such patients after more severe dehydration or a water load, or both. The state of antidiuresis or diuresis in this patient at the time of the original renogram was not determined. Subsequent renograms made with the patient in a state of antidiuresis were abnormal on the more severely involved side.

**Pyelonephritis**

Ten patients were shown to have unilateral or bilateral pyelonephritis. The clinical history was in most cases helpful in that the patient had been aware of recurrent infection of the urinary tract. The average age was 46 years. Hypertension had been known for 2 years or longer. One patient had retinopathy of group 3 hypertension and nine had discoscopic changes of group 2 hypertension (Keith-Wagener-Barker). The disease was predominantly unilateral in eight and bilateral in two cases. One of the patients with bilateral disease had mild renal insufficiency.

None of these 10 patients had abdominal bruits. The urograms were considered diagnostic of pyelonephritis in all instances. The pole-to-pole diameter of the more severely diseased kidney was at least 2 and as much as 5 cm. less than that of the contralateral kidney. Five patients were considered surgical candidates because of hypertension and in one case because of hypertension and obstruction of the ureteropelvic junction with recurrent symptomatic infection.

The isotope renogram was abnormal in all patients with pyelonephritis. In the absence of ureteral obstruction, the degree of abnormality seemed largely dependent on the degree of destruction of functioning renal parenchyma. The renogram illustrated in figure 8 was obtained in the presence of an atrophic right kidney with little remaining function and a functionally hypertrophied left kidney. Nephrectomy resulted in relief of hypertension. The renogram of a patient with obstruction of the ureteropelvic junction, pyelonephritis, and hypertension is illustrated in figure 9. There is evidence of delayed excretion of the labeled medium. Function on the involved side is otherwise good. In such
instances it is necessary to obtain urographic studies to determine whether obstructive uropathy is present, or arteriography to determine whether the changes are the result of renal artery stenosis. We have obtained renographic demonstration of mild ureteral obstruction which could not be detected by excretory urography but was confirmed by retrograde urograms. When parenchymal disease is bilateral and there is no obstruction, the renogram values are customarily decreased in relation to the extent of renal destruction. Even in the presence of unilateral disease, the renographic findings do not permit a clear distinction between pyelonephritis and renal artery stenosis.

**Miscellaneous**

One patient each was found to have primary aldosteronism, pheochromocytoma, and nephrocalcinosis apparently secondary to renal tubular acidosis. These patients were 24, 38, and 28 years old and had known of their hypertension for 6, 3, and 4 years, respectively. The patients with aldosteronism and pheochromocytoma had normal urograms and renograms; the former had a normal renal arteriogram. In the third patient the urogram revealed the nephrocalcinosis, but there was no evidence of pyelonephritis of the calyceal system; the arteriogram was normal, but the renogram was bilaterally abnormal. Hypertension was relieved following removal of the adrenal tumors in the patients with primary aldosteronism and pheochromocytoma.

**Essential Hypertension**

Evidence of secondary hypertension was not demonstrated in 44 patients. As previously noted, the clinical history and physical examination were not of particular assistance in the exclusion of secondary hypertension in these patients. The diagnosis was largely established on the basis of lack of evidence of a specific etiology. Certain laboratory observations, however, were of interest to us. In 80 per cent of these patients the difference in the pole-to-pole diameter of the kidneys was less than 1 cm. Although renal arteriography was undertaken in only 15 of the 44 patients, results of the examination were normal on all occasions. When separated renal function studies were undertaken, there was essentially equal function of the two kidneys. When comparison was made with the renogram studies, 41 of the 44 patients were considered to have normal renograms (fig. 10). The three patients with abnormal renograms were found to have essentially equal function bilaterally, and the findings were thought consistent with long-standing renal or reno-
vascular disease (fig. 11). Arteriography or studies of separated renal function in the three patients with abnormal renograms had failed to reveal evidence for renal artery stenosis. These findings are in accord with those of Baldwin and associates in their studies of the function of the separate kidneys in patients with essential hypertension. We do not propose, however, that renovascular hypertension is thereby excluded in all patients in this group, and it is our practice to undertake additional investigation should the patient's subsequent clinical course suggest possible secondary hypertension.

**Clinical Usefulness of the Isotope Renogram in Hypertensive Subjects**

Taplin and associates have advocated the use of the isotope renogram as a renal function test. Numerous investigators have subsequently and with varied success utilized this procedure in the study of patients for evidence of renal and renovascular causes of hypertension. Standardization of this procedure and the establishment of the range of values for normal subjects have permitted us to use the renogram not only as a renal function test but especially as a screening procedure for evidence of unilateral renal or renovascular disease in hypertensive patients. Less pronounced differences are sometimes noted with bilateral disease; however, unilaterally or bilaterally abnormal values are usually noted in such patients. When the renogram is abnormal, further investigation is warranted. When the renogram is within normal limits, it is our practice to undertake further investigation as seems clinically warranted in individual patients. In this study, only one patient with a normal initial renogram was found on arteriography to have renal artery stenosis. The lesions were bilateral and prompted subsequent revision of our renographic procedure to permit demonstration of less pronounced differences in renal function. Studies to determine the incidence of abnormal renograms in the absence of renal or renovascular disease are presently in progress. Our application of the isotope renogram in the study of hypertensive patients to date has caused us to consider this procedure a valuable laboratory aid that is reasonably simple to perform, of little discomfort and no hazard to the patient, and readily applicable to the study of a large volume of patients. The procedure complements urographic, arteriographic, and separated renal function technics.

**Summary**

Sodium ortho-iodohippurate (Hippuran) I³¹ renography has been performed by a standardized technic in patients with renal artery stenosis, pyelonephritis, primary aldos-
teronism, pheochromocytoma, and renal tubular acidosis with nephrocalcinosis, as well as in patients in whom the hypertension was apparently not secondary. Fifty of 94 patients studied were found to have abnormal renograms.

In patients with renal artery stenosis, all of 37 patients studied had values on the renogram that were outside the range for normal subjects. Although the renographic findings were not considered diagnostic of renal artery stenosis, certain abnormalities of the renogram were commonly observed in the presence of such lesions. When a unilateral delay in the appearance of maximal radioactivity was associated with delayed disappearance of the medium, renal artery stenosis was frequently observed. Less pronounced differences in the function of the two kidneys were observed in patients with bilateral renal artery stenosis. A state of antidiuresis was often found helpful in the detection of less severe differences in renal function.

In patients with predominantly unilateral pyelonephritis, the renographic abnormalities were qualitatively consistent with the degree of impairment of renal function. Bilateral abnormalities were observed in two patients who had bilateral parenchymal disease. The abnormalities on the renogram did not permit distinction between renovascular and renal parenchymal disease. Pyelonephritis associated with obstructive uropathy revealed findings highly suggestive of renal artery stenosis. Distinction from renovascular lesions could be determined with the aid of urographic studies.

Only three of 44 patients with essential hypertension had abnormal renograms. The renograms, normal and abnormal, revealed essentially equal function of the two kidneys. The patients with abnormal renograms were not found by other technics to have evidence of secondary hypertension.

The patients who were found to have pheochromocytoma and primary aldosteronism had normal isotope renograms. The patient with renal tubular acidosis and nephrocalcinosis had a bilaterally abnormal renogram and severe impairment of total renal function.

The presence of a normal isotope renogram, as performed in our laboratory, is considered strong evidence against the existence of a renal or renovascular cause for secondary hypertension.

References


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