Comparison of Duplex Ultrasound with Angiography

<table>
<thead>
<tr>
<th>Percent stenosis by ultrasound</th>
<th>Percent stenosis by arteriogram</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-59</td>
<td>62 0 1 1 64</td>
</tr>
<tr>
<td>60-99</td>
<td>1 31 67 0 99</td>
</tr>
<tr>
<td>100</td>
<td>0 1 1 22 24</td>
</tr>
<tr>
<td>Total</td>
<td>63 32 69 23 187</td>
</tr>
</tbody>
</table>

Sensitivity, 0.98.
Specificity, 0.98.
Positive predictive value, 0.99.
Negative predictive value, 0.97.

Determination of Pathophysiologic Significance of the Stenotic Lesion

- Duration of hypertension <3-5 y
- Appearance of lesion on angiogram (>75% stenosis)
- Systolic-diastolic bruit in abdomen
- Renal vein renin ratio >1.5
- Positive captopril provocation test or captopril renogram
- Abnormal rapid sequence IVP
- Hypokalemia

Comparison of duplex ultrasound with arteriography. A total of 102 consecutive patients with both duplex ultrasound scanning of the renal arteries and renal arteriography were prospectively studied. All patients in this study had difficult-to-control hypertension, unexplained azotemia, or associated peripheral vascular disease, giving them a high pretest likelihood of renovascular hypertension. Sixty-two of 63 arteries that showed less than 60% stenosis by formal arteriography, were identified by duplex ultrasound scanning.

Twenty-two of 23 arteries with total occlusion on arteriography were correctly identified by duplex ultrasound. Thirty-one of 32 arteries with 60% to 79% stenosis using arteriography were identified as having 60% to 99% stenosis on duplex ultrasound and 67 of 69 arteries with 80% to 99% stenosis on arteriography were detected to have 60% to 99% stenosis on ultrasound. A current limitation of duplex ultrasound is the inability to consistently distinguish between more than and less than 80% stenosis (considered to be the magnitude of stenosis required for hemodynamic significance of the lesion). Nevertheless, duplex ultrasound is currently highly sensitive and specific in patients with a high likelihood of renovascular disease in detecting patients with more or less than 60% renal artery stenosis. Accessory renal arteries are difficult to identify by ultrasound and remain a limitation of this test. (Adapted from Olin and coworkers [5]; with permission.)

Determination of pathophysiologic significance of the stenotic lesion. The second step in making the diagnosis of renovascular hypertension (RVHT) is to determine the pathophysiologic significance of the stenotic lesion demonstrated by angiography. The likelihood of cure of the hypertension by an interventional maneuver is greatly enhanced when one or more of the items listed here are present. A positive captopril provocation test, abnormal rapid sequence intravenous pyelogram (IVP), or positive captopril renogram not only suggest the anatomic presence of renal artery stenosis but also imply that the stenosis is instrumental in producing the hypertension. Reductions of lumen diameter of less than 70% to 80% generally do not initiate renal ischemia or activation of the renin angiotensin system; thus, before recommending a renal revascularization procedure, severe renal artery stenosis (>75% reduction in lumen diameter) should be observed on the renal angiogram. A lateralizing renal vein renin ratio (a comparison of renin harvested from the renal vein ipsilateral to the renal artery stenosis with the renin level from renal vein of the contralateral kidney), particularly when renin production from the contralateral kidney is suppressed, suggests that an intervention on the renal artery stenosis will cure or markedly ameliorate the hypertension in about 90% of cases. Conversely, cure or marked improvement in blood pressure following renal revascularization has been reported in nearly 50% of cases in the absence of lateralizing renal vein renins. Hypokalemia, in the absence of diuretic therapy, strongly suggests that the hypertension is renovascular in origin, consequent to secondary aldosteronism. The sensitivity of an IVP in detecting unilateral RVHT is relatively poor (about 75%) and the overall sensitivity in detecting patients with bilateral renal artery disease is only about 60%. Because RVHT has a low prevalence in the general population, a negative IVP provides strong evidence (98% to 99% certainty) against RVHT.
Renovascular Hypertension and Ischemic Nephropathy

3.11

RENIN CRITERIA FOR CAPTOPRIL TEST THAT DISTINGUISH PATIENTS WITH RVHT FROM THOSE WITH ESSENTIAL HYPERTENSION

- Stimulated PRA of 12 ng/mL/h or more
- Absolute increase in PRA of 10 ng/mL/h or more
- Percent increase in PRA
- Increase in PRA of 150% if baseline PRA >3 ng/mL/h
- Increase in PRA of 400% if baseline PRA <3 ng/mL/h

FIGURE 3-18
The captopril test: renin criteria that distinguish patients with renovascular hypertension from those with essential hypertension. The captopril provocation test evolved because the casual measurement of peripheral plasma renin activity (PRA) has been of little value as a diagnostic screening test for renovascular hypertension (RVHT). The notion that patients with high PRA, even in the face of high urinary sodium excretion, might turn out to have RVHT has not been supported by numerous clinical observations. However, the short-term (60- to 90-minute) response of blood pressure and PRA to an oral dose (25 to 50 mg) of captopril has gained recent popularity as a screening test for presumed RVHT. Preparation of patients for this test is vital; ideally patients should discontinue their antihypertensive medications, maintain a diet adequate in salt, and have good renal function. A baseline blood pressure and PRA are obtained after which captopril is administered; 60 minutes after captopril administration, a “post-captopril” PRA is obtained along with repeat measurements of blood pressure. Early reports with this test indicated a high sensitivity and specificity (95% to 100%) in identifying RVHT if all three of the renin criteria listed here were met. Subsequent reports have not been as encouraging such that the overall sensitivity of this captopril test is only about 70%, with a specificity of approximately 85%. (Adapted from Muller and coworkers [6]; with permission.)

FIGURE 3-19
Captopril renography. A, TcDPTA time-activity curves during baseline. B, TcDPTA time-activity curves after captopril administration. These curves represent a captopril renogram in a patient with unilateral left renal artery stenosis. This diagnostic test has been used to screen for renal artery stenosis and to predict renovascular hypertension. Captopril renography appears to be highly sensitive and specific for detecting physiologically significant renal artery stenosis. Scintigrams and time-activity curves should both be analyzed to assess renal perfusion, function, and size. If the renogram following captopril administration is abnormal (panel B, demonstrating delayed time to maximal activity and retention of the radionuclide in the right kidney), another renogram may be obtained without captopril for comparison. The diagnosis of renal artery stenosis is based on asymmetry of renal size and function and on specific, captopril-induced changes in the renogram, including delayed time to maximal activity (≥11 minutes), significant asymmetry of the peak of each kidney, marked cortical retention of the radionuclide, and marked reduction in the calculated glomerular filtration rate of the kidney ipsilateral to the stenosis. One must interpret the clinical and renographic data with caution, as protocols are complex and diagnostic criteria are not well standardized. Nevertheless, captopril renography appears to be an improvement over the captopril provocation test, with many reports indicating sensitivity and specificity from 80% to 95% in predicting an improvement in blood pressure following intervention. (Adapted from Nally and coworkers [7]; with permission.)
Hypertension and the Kidney

Suggested work-up for renovascular hypertension

- **Index of clinical suspicion**
  - Low (<1%)
  - Moderate (≈5%-15%)
  - High (>25%)

- **PRA**
  - Low
  - Normal or high

- **Captopril test, or captopril renogram, or stimulated renal vein renins, or (?) duplex ultrasound**

- **Arteriogram + renal vein renins**

**FIGURE 3-20**
Suggested work-up for renovascular hypertension. Because the prevalence of renovascular hypertension (RVHT) among hypertensive persons in general is approximately 2% or less, widespread screening for renovascular disease is not justified. Despite the proliferation of diagnostic tests now available to detect renal artery stenosis and several tests designed to predict the physiologic significance of the stenotic lesion, the index of clinical suspicion for RVHT remains the focal point of the work-up for RVHT. A brief duration of moderately severe hypertension is the most important clue directing subsequent work-up for RVHT. If the index of clinical suspicion (see Fig. 3-14) is high, it is reasonable to proceed directly to formal renal arteriography with renal vein renin determination. Alternatively, in patients highly suspected to have RVHT, a captopril renogram followed by a renal arteriogram may be recommended. Strong arguments against RVHT include 1) long duration (more than 5 years) of hypertension, 2) old age, 3) generalized atherosclerosis, 4) increased serum creatinine, and 5) a normal serum potassium concentration. For these patients, particularly if the blood pressure is only minimally elevated or easily controlled with one or two antihypertensive medications, further work-up for RVHT is not indicated. (Adapted from Mann and Pickering [8]; with permission.)

Ischemic Nephropathy

**FIGURE 3-21**
Aortogram in a 62-year-old white woman demonstrating subtotal occlusion of the left main renal artery supplying an atrophic left kidney and high-grade ostial stenosis of the proximal right renal artery from atherosclerosis. This patient presented in 1977 with a recent appearance of hypertension and a blood pressure of 170/115 mm Hg. Three years previously, when diagnosed with polycythemia vera, an IVP was normal. She was followed closely between 1974 and 1977 by her physician and was always normotensive until the hypertension suddenly appeared. A repeat rapid sequence IVP demonstrated a reduction in the size of the left kidney from 14 cm in height (1974) to 11.5 cm in height (1977). The serum creatinine was 2.6 mg/dL. The renal arteriogram shown here indicates high-grade bilateral renal artery stenosis with the left kidney measuring 11.5 cm in height, and the right kidney measuring 14.5 cm in height. Renal vein renins were obtained and lateralized strongly to the smaller left kidney. The blood pressure was well controlled with inderal and chlorthalidone. Right aortorenal reimplantation was undertaken solely to preserve renal function. Postoperatively the serum creatinine fell to 1.5 mg/dL and remained at this level for the next 13 years. Blood pressure continued to require antihypertensive medication, but was controlled to normal levels with inderal and chlorthalidone.