or angiotensin-receptor blocker (ARB). If the arteries to both kidneys are narrowed, pressure natriuresis does not occur, and hypertension is maintained chronically by the resulting intravascular volume expansion rather than by increased total peripheral resistance. Treatment with diuretics becomes more important in this circumstance. The latter situation also occurs when there is only a single functioning kidney that has stenosis or when an initially normal contralateral kidney suffers microvascular damage from long-standing hypertension (Fig. 30-2).

The pathophysiology of hypertension with RAS is such that its treatment may also compromise kidney function and reduce the GFR. If the kidney contralateral to one with hemodynamically significant RAS is normal, lowering the systemic blood pressure maintains the kidney with the stenosis in a vascularly compromised state. However, this may not be detectable by measurement of the serum creatinine level because of the normally functioning contralateral kidney. A decline in the GFR may be evident if there is underlying renal dysfunction in the contralateral kidney, as is often the case in long-standing hypertension, diabetes, or vascular disease. When a solitary functioning kidney or both kidneys are affected (i.e., bilateral RAS), AKI may result when ACE inhibitor or ARB treatment is initiated.

Atherosclerotic Renovascular Disease

Clinical Presentation

Atherosclerosis is the primary cause of RAS, although any process that narrows one or both renal arteries may cause renal ischemia; others are discussed later in this chapter. Atherosclerotic renovascular disease is a common form of secondary hypertension, affecting up to 5% of patients with hypertension. Atherosclerotic RAS rarely occurs in patients younger than 40 years, and it is more common in men, whites, smokers, diabetics, and patients with atherosclerotic disease in other arterial systems.

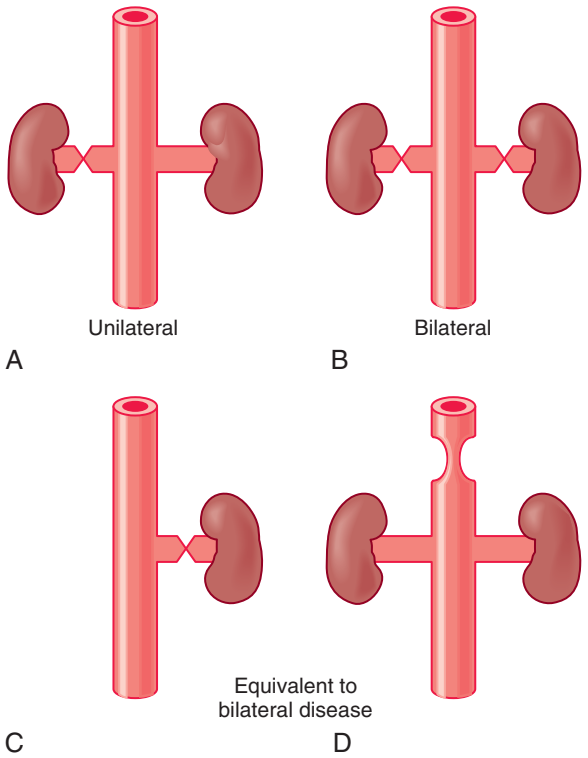

FIGURE 30-2 Anatomy of renal artery stenosis. Renal artery stenosis may be unilateral (**A**), bilateral (**B**), or unilateral with a solitary kidney (**C**). Aortic disease may serve functionally as bilateral renal artery stenosis (**D**).

RAS should be suspected in patients with refractory hypertension or new-onset hypertension in patients older than 50 years, particularly if they have overt risk factors for atherosclerotic RAS (Table 30-1). Evaluation should always begin with a thorough history and physical examination, including attention to blood pressure and pulse amplitude in each extremity. A significant discrepancy between extremities may indicate peripheral vascular disease and increase the likelihood of RAS. An abdominal bruit is detected in about 50% of subjects but is not specific for RAS. Edema is not typically found unless significant CKD or another edematous condition also exists.

Laboratory evaluation may reveal hypokalemia (K^+ <3.5 mEq/L) or metabolic alkalosis (HCO_3^- >28 mEq/L) due to secondary hyperaldosteronism. A reduced GFR with an elevated serum creatinine concentration may be found, but a normal serum creatinine level does not rule out hemodynamically significant RAS. Plasma renin activity and aldosterone concentrations may be elevated, but their measurement is of limited clinical utility in assessing hypertensive patients for RAS or in making therapeutic decisions. Urinalysis results are usually normal, although low-grade proteinuria (usually <1 g/day) from long-standing hypertension may be seen.

Diagnosis

Standard renal ultrasound imaging provides a limited window into the detection of RAS by revealing a discrepancy in kidney size, which develops only after prolonged ischemia and irreversible renal injury. However, a change in kidney size over time on serial imaging in the setting of known RAS may prompt the clinician to consider treatment with angioplasty and stenting or with surgical revascularization.

Renal ultrasound with pulsed Doppler analysis provides information about flow velocity in the renal arteries that may be helpful in detecting hemodynamically significant RAS. However, renal duplex ultrasonography is technically demanding, particularly in obese patients, and it is best performed by an experienced ultrasonographer at a high-volume center with a proven track record of high diagnostic accuracy. At most centers, the sensitivity, specificity, and positive and negative predictive values of renal

TABLE 30-1 CLINICAL FINDINGS SUGGESTING ATHEROSCLEROTIC RENOVASCULAR DISEASE

Onset of new, severe hypertension or sudden worsening of chronic hypertension at >55 years of age
Accelerated, resistant, or malignant hypertension
Unexplained atrophic kidney or size discrepancy >1.5 cm between kidneys
Sudden, unexplained ("flash") pulmonary edema
Unexplained chronic kidney disease in an individual with atherosclerotic vascular disease elsewhere
Development of acute kidney injury or worsening of chronic kidney disease after starting an ACE inhibitor or ARB

ACE, Angiotensin-converting enzyme; ARB, angiotensin II–receptor blocker.