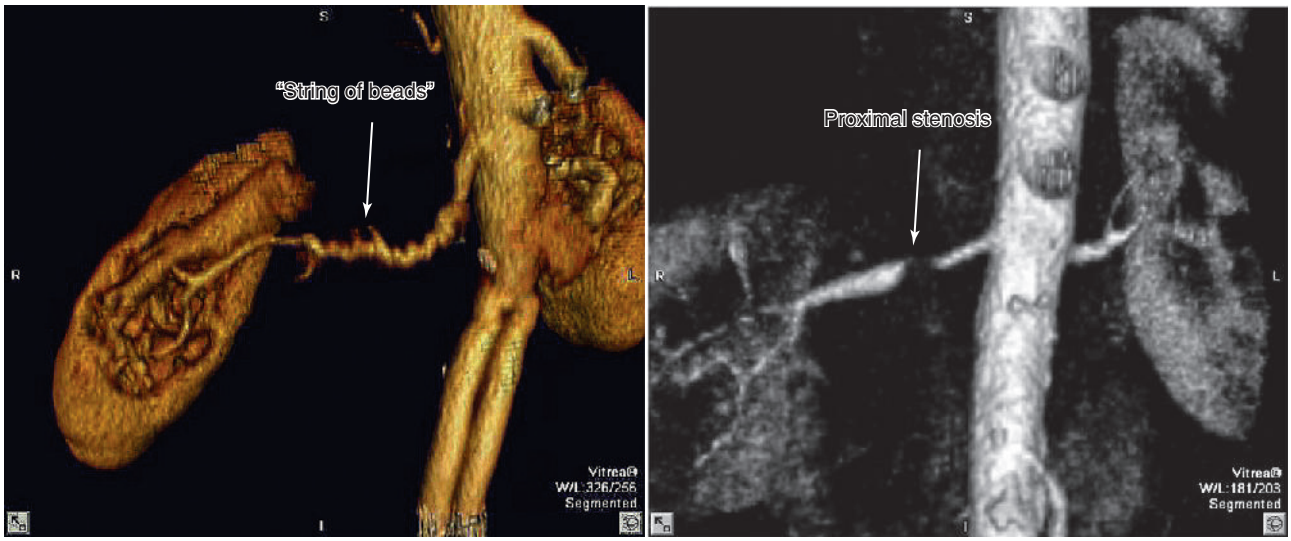

FIGURE 12-10 Computed tomography angiogram with three-dimensional reconstruction. **A,** Classic string-of-beads lesion of fibromuscular dysplasia. **B,** Severe proximal atherosclerotic stenosis of the right renal artery. (Courtesy Bart Domatch, MD, Radiology Department, University of Texas Southwestern Medical Center, Dallas, Tex.)

considered for medically refractory hypertension, progressive renal failure while on medical therapy, and bilateral renal artery stenosis or stenosis of a solitary functioning kidney.

Primary Aldosteronism

The most common causes of primary aldosteronism are a unilateral aldosterone-producing adenoma and bilateral adrenal hyperplasia. Because aldosterone is the principal ligand for the mineralocorticoid receptor in the distal nephron, excessive aldosterone production causes excessive renal Na^+-K^+ exchange, often resulting in hypokalemia. The diagnosis should always be suggested when hypertension is accompanied by either unprovoked hypokalemia (serum K^+ <3.5 mmol/L in the absence of diuretic therapy) or a tendency to develop excessive hypokalemia during diuretic therapy (serum K^+ <3.0 mmol/L). However, more than one third of patients do not have hypokalemia on initial presentation, and the diagnosis should be considered in any patient with refractory hypertension.

The diagnosis is confirmed by the demonstration of nonsuppressible hyperaldosteronism during salt loading, followed by adrenal vein sampling to distinguish between a unilateral adenoma and bilateral hyperplasia. Laparoscopic adrenalectomy is the treatment of choice for unilateral aldosterone-producing adenoma, whereas pharmacologic mineralocorticoid-receptor blockade with eplerenone is the treatment for bilateral adrenal hyperplasia.

Mendelian Forms of Hypertension

Nine very rare forms of severe early-onset hypertension are inherited as mendelian traits. In each case, the hypertension is mineralocorticoid induced and involves excessive activation of the epithelial sodium channel ($E_{Na}C$), the final common pathway for reabsorption of sodium from the distal nephron. The resultant salt-dependent hypertension can be caused by gain-of-function mutations of $E_{Na}C$ (Liddle's syndrome) or the mineralocorticoid receptor (a rare form of pregnancy-induced hypertension) or by increased production or decreased clearance of mineralocorticoids including aldosterone (glucocorticoid-remediable aldosteronism), deoxycorticosterone (17-hydroxylase deficiency), and cortisol (syndrome of apparent mineralocorticoid excess). Mutations in the potassium-channel subunit KCNJ5 and in TWIK-related acid-sensitive K^+ channel (TASK) have been linked to familial aldosteronism because they increase aldosterone release or increase proliferation of zona glomerulosa cells.

Pheochromocytoma and Paraganglioma

Pheochromocytomas are rare catecholamine-producing tumors of the adrenal chromaffin cells. Paragangliomas are even rarer extra-adrenal catcholamine-producing or nonfunctional tumors of sympathetic and parasympathetic ganglia. The diagnosis should be suggested when hypertension is accompanied by paroxysms of headaches, palpitations, pallor, or diaphoresis. However, the most common presentation of pheochromocytoma is that of an adrenal incidentaloma—an incidental adrenal mass discovered unexpectedly on abdominal imaging for another indication. In some patients, pheochromocytoma is misdiagnosed as panic disorder. A family history of early-onset hypertension may suggest pheochromocytoma as part of the multiple endocrine neoplasia (MEN) syndromes or familial paraganglioma. If the diagnosis is missed, then outpouring of catecholamines from the tumor can cause an unsuspected hypertensive crisis during unrelated radiologic or surgical procedures; the perioperative mortality rate exceeds 80% in such circumstances.

Laboratory confirmation of pheochromocytoma is made by demonstration of elevated levels of plasma or urinary metanephrines; these are methylated derivatives of norepinephrine and epinephrine that are made in the adrenal medulla and continually leak out into the plasma even between BP spikes. Pheochromocytomas are typically large adrenal tumors that can usually be localized by CT or MR imaging, although nuclear scanning with