

Search...

Aortic Diseases

• Key Points

- - CT scanning is the dominant imaging test for the assessment of acute aortic diseases.
- - Without ECG-gating, motion artifacts are still a problem for assessment of the ascending aorta and root; ECG-gating obviates such artifacts and provides superlative imaging detail for what was formerly a problem area for CT imaging.
- - Knowledge of the range of aortic lesions and their complications is imperative.

CT scanning has emerged as the de facto test of choice for the identification of diseases of the aorta. As a result of its widespread and 24-hour availability, its suitability to evaluate critically ill patients (as long as they can be moved), and the appropriateness of its spatial and temporal resolution to the needs of most aortic pathologies, CT scanning has become the principal test for the evaluation of diseases of the aorta. Although CT scanning is the leading test to diagnose structural disease of the aorta, it is less able to diagnose the functional consequences of such disease. Often, therefore, CT scanning is combined with another modality to establish both the anatomic and functional disturbances of aortic disease. For example, although both CT scanning and echocardiography are strong tests to identify dissection of the aorta, most patients are managed with both, because CT identifies a far greater extent of the aorta than echocardiography does, but echocardiography is better for identifying cardiac complications (e.g., aortic insufficiency, cardiac tamponade and myocardial ischemia). Integrated imaging strategies remain the most clinically solid approach.

The only issues limiting the use of CT are the risks of radiation and of contrast-related renal insufficiency. To reduce the risks of radiation where they are most harmful, therefore, evaluation of aortic congenital malformations (such as coarctation) in very young patients is performed by magnetic resonance imaging or angiography (MRI/MRA).

Sixteen-slice CCT was already such a powerful modality for the diagnosis of the structural aspects of aortic disease that the improvements that occurred as 40- and 64-slice CCT were developed to assess cardiac (coronary) disease only enhanced CCT's dominance. Imaging techniques that struggle with coronary artery imaging are generally more successful with aortic imaging because the aorta is almost a logarithm greater in size and is subject to less motion than the coronary arteries.

Normal thoracic aortic diameters overall and by gender are presented in [Table 26-1](#) .

TABLE 26-1
Normal Thoracic Aortic Diameters Overall and by Gender
OVERALL (*n* = 103), MEAN (SD) WOMEN (*n* = 44), MEAN (SD) MEN (*n* = 59), MEAN (SD) *P* value

Aortic Root			
Diameter, short-axis ED (cm)	3.1 (0.3)	2.9 (0.2)	3.2 (0.3)
Area, short-axis ED (cm 2)	7.9 (1.6)	6.9 (1.4)	8.5 (1.7)
Ascending Aorta			
Diameter, short-axis ED (cm)	2.8 (0.4)	2.8 (0.4)	2.8 (0.3)
Diameter, short-axis ES (cm)	3.0 (0.3)	2.9 (0.4)	3.0 (0.3)
Diameter, axial ES (cm)	3.0 (0.3)	3.0 (0.4)	3.1 (0.3)
Descending Thoracic Aorta			
Diameter, short-axis ED (cm)	2.1 (0.2)	2.0 (0.2)	2.2 (0.2)
Diameter, short-axis ES (cm)	2.2 (0.2)	2.2 (0.2)	2.3 (0.2)
Diameter, axial ES (cm)	2.3 (0.2)	2.1 (0.1)	2.3 (0.3)

☐ ED, end-diastolic; ES, end-systolic.
Data from Lin FY, Devereux RB, Roman MJ, et al. Assessment of the thoracic aorta by multidetector computed tomography: age- and sex-specific reference values in adults without evident cardiovascular disease. *J Cardiovasc Comput Tomogr*. 2008;2(5):298-308.

CT Artifacts and Aortic Diseases

Although CT is the principal diagnostic test for diseases of the aorta, CT artifacts may confound assessment of aortic diseases. The older the CT scanner, the greater the number of artifacts (at least half of CT studies on scanners from 1999 or earlier have significant artifacts over the ascending aorta).

Potentially problematic artifacts include:

- ☐ Streak artifacts off the brachiocephalic vein (from contrast), confounding assessment of the aortic arch behind it
- ☐ Streak artifacts off the superior vena cava (from contrast or pacer wires), confounding assessment of the ascending aorta beside it
- ☐

Streak artifacts off the spine, confounding assessment of the descending aorta beside it

- □ Older scanners (slow, or without cardiac gating) may generate “pulsation” artifacts of superimposed images of the aorta in different positions due to translation from cardiac motion, conferring the impression of an intimal flap. There is almost 1 cm of translational motion of the ascending aorta through the cardiac cycle.
- □ Motion artifacts
- □ See [Figure 26-1](#) .

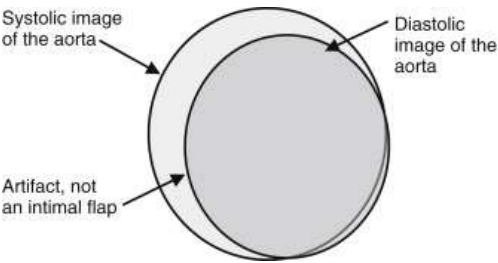


Figure 26-1
The systolic motion (translation and pulsation) of the aorta on non-ECG-gated imaging may render a superimposition image artifact to suggest an intimal flap.

Atherosclerotic Calcification

Atherosclerotic plaques in the aorta are extremely common. The two sites most often involved are the abdominal aorta and the distal floor of the arch. Although there is general correlation between the extent of aortic and coronary atherosclerosis, many patients will have small flecks of aortic calcification without having significant coronary disease.

Intimal calcification is a marker of intimal position. “Intimal displacement” (into the lumen) is a convenient sign of mural thickening due to either occurrence of a false lumen within the wall of the aorta or development of intramural hematoma. If there is thickening over (i.e., on the luminal side of) intimal calcification, it usually is from thrombus, particularly if the aorta is dilated at that site.

For images of calcification of the aorta, see [Figures 26-2 and 26-3](#) .

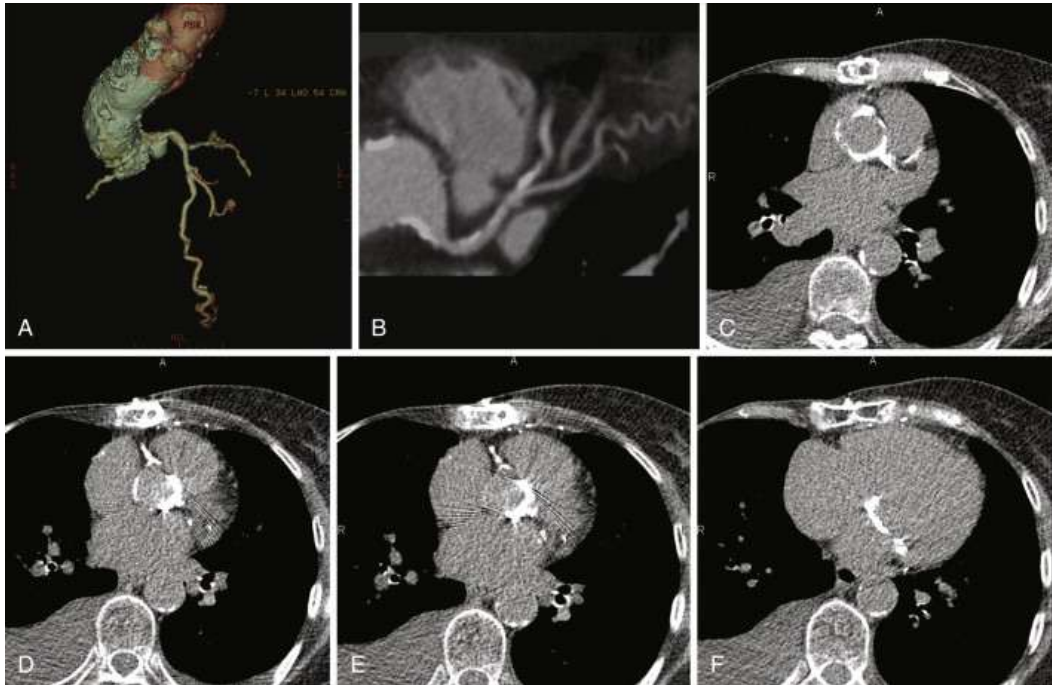


Figure 26-2
Porcelain aorta—unclampable in the ascending segment. **A**, Three-dimensional volume-rendered image of the aortic root and ascending aorta reveals extensive contiguous and circumferential calcification of the aorta well into the ascending portion. Above that, the calcification is spotty. **B**, Calcification at the ostium of the left main stem coronary artery and in a plaque in the left anterior descending artery. All the coronary arteries had extensive “hard” plaques. **C** and **D**, Non-contrast-enhanced axial CT images reveal nearly circumferential calcification of the aortic root and calcification down the proximal left coronary artery (**C**) and down the proximal right coronary artery (**D**). **E** and **F** , Extensive aortic valve and annular calcification (**E**) and mitral annular calcification (**F**).

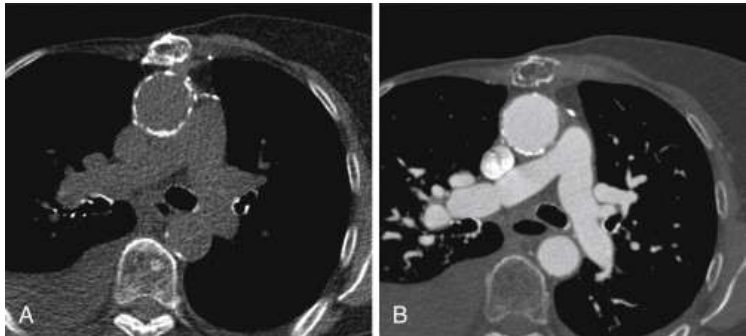


Figure 26-3
Cardiac CT images of a 78-year-old man being assessed for a redo coronary artery bypass graft (CABG). **A**, The precontrast image demonstrates extensive—almost circumferential—calcification around the ascending aorta. This configuration can be termed a *porcelain aorta*. **B**, Administration of intravenous contrast

somewhat decreases the conspicuity of the underlying extensive aortic calcification. An evaluation of the extent of calcification and atherosclerotic disease of the ascending aorta is available to the cardiothoracic surgeon in the planning of the patient’s redo CABG by noncontrast CT scanning.

Aortic Dissection

CT is the principal modality used to diagnose acute aortic dissection (AAD). CCT has emerged as the initial diagnostic modality to identify or exclude AAD by virtue of:

- ☐ Imaging both the thoracic and abdominal aorta (vs. echocardiography), which has far more limited field-of-view
- ☐ Its speed (vs. MRI)
- ☐ Its very high degree of accuracy (vs. angiography)
- ☐ Its ability to image the majority of side branches (vs. echocardiography)
- ☐ Its ability to image important variants of dissection such as intramural hematoma (vs. angiography)
- ☐ The fact that most referring physicians are comfortably familiar with it

Studies comparing CT to other modalities were numerous 12 to 15 years ago; however, few studies have been done involving the current generation of CT equipment. Studies from a decade ago cannot depict the relative accuracy of any test that has developed as much as CCT has in the past 5 years. To further complicate comparisons, TEE and MRI also have evolved over the last decade.

Findings of aortic dissection that CCT is able to image include:

- ☐ Intimal flap
- ☐ False lumen. The false lumen generally arises off the outer curvature of the aorta (as the tear is usually located on the outside curvature).
- ☐ Thrombosis within the false lumen (suggests/consistent with chronicity or healing)
- ☐ Entry tear. The two most common sites of entry tears are 2 cm above the aortic valve and 1 cm distal to the left subclavian artery.
- ☐ Exit (re-entry) tear
- ☐ Pleural effusion
- ☐ Pericardial effusion
- ☐ Mediastinal hematoma
- ☐ Branch vessel involvement. The finding that a branch vessel arises from the false lumen does not establish that its vascular bed is underperfused, only that it is jeopardized. One of the few signs of vascular bed hypoperfusion that is clinically supported is that of pallor of the kidneys during a contrast-enhanced scan.
- ☐ Coronary artery involvement, especially if ECG gating is employed

The diagnosis of a dissection is made when an intimal flap is identified. Lack of thrombosis within the false lumen supports acuity of the dissection, while thrombosis supports chronicity.

Potential false positives that may occur include streak artifact from residual contrast in the SVC across the ascending aorta appearing as linear artifact masquerading as an intimal flap. The linearity of the line artifact across the ascending aorta, the presence of multiple lines, the presence of nearby bright lines, and the traversing of tissue planes by the lines indicate that these are artifact. Intimal flaps are not straight in their entirety.

CCT is the most commonly used modality for following aortic diameter in patients with aortic dissection in the chronic phase and is able to identify progressive enlargement as well as persistence of flow in the false lumen. Aortic diameter of type B (distal) dissection cases increases in 37% of cases with a thrombosed false lumen and in 90% of cases with a persistent false lumen. Growth rate has been noted to be 4 ± 7 mm/year in the ascending aorta, 2 ± 9 mm/year in the arch, and 1 ± 6 mm/year in the descending aorta.

For images of acute aortic dissection, see [Figures 26-4 through 26-13](#) and **Video 26-1.**

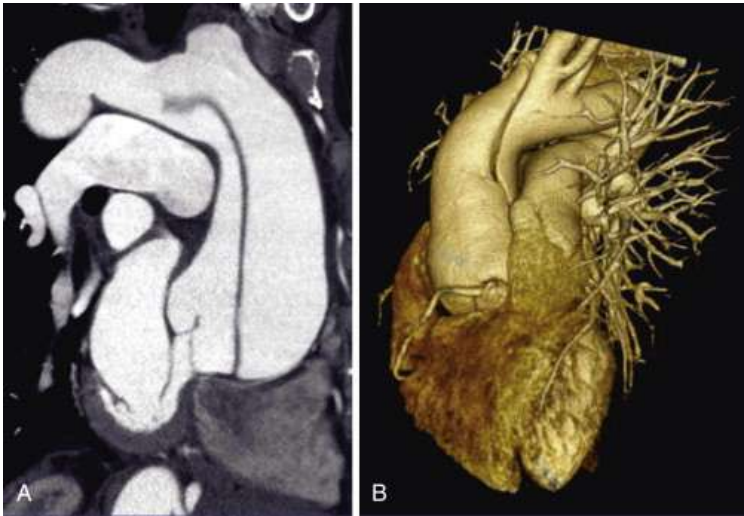


Figure 26-4
Composite images from a cardiac CT study in a patient with Marfan syndrome demonstrate a type A dissection with an associated ascending aortic aneurysm. No extension of this flap into either coronary artery was present.

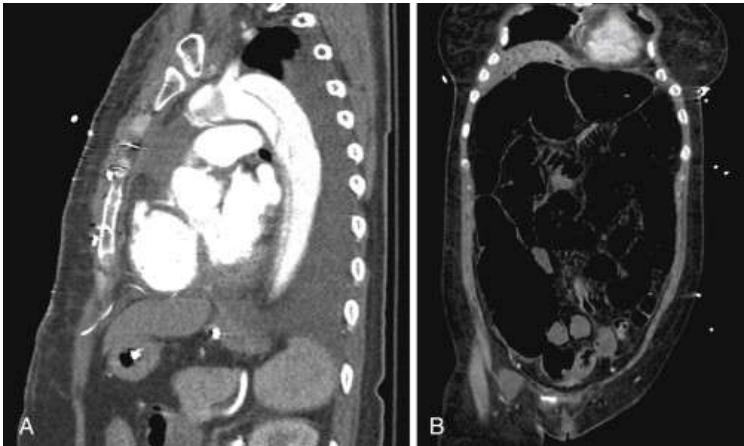


Figure 26-5
A, The left sagittal view displays an intimal tear immediately distal to the left subclavian artery, and a flap extending distally. There are sternal wires from a recent aortocoronary bypass grafting operation. **B**, The right coronal abdominal view reveals gross distention with air, due to mesenteric ischemia malperfusion from the dissection flap.

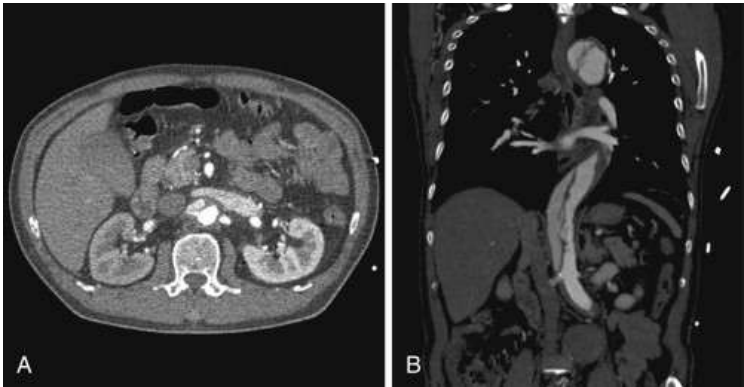


Figure 26-6
Acute type B aortic dissection with protracted hypertensive crisis. The intimal flap can be seen to the right renal ostium and may continue past the calcified plaque into the proximal renal artery. The right kidney enhances less than the left one. The diagnosis was renal ischemia and refractory hypertension.

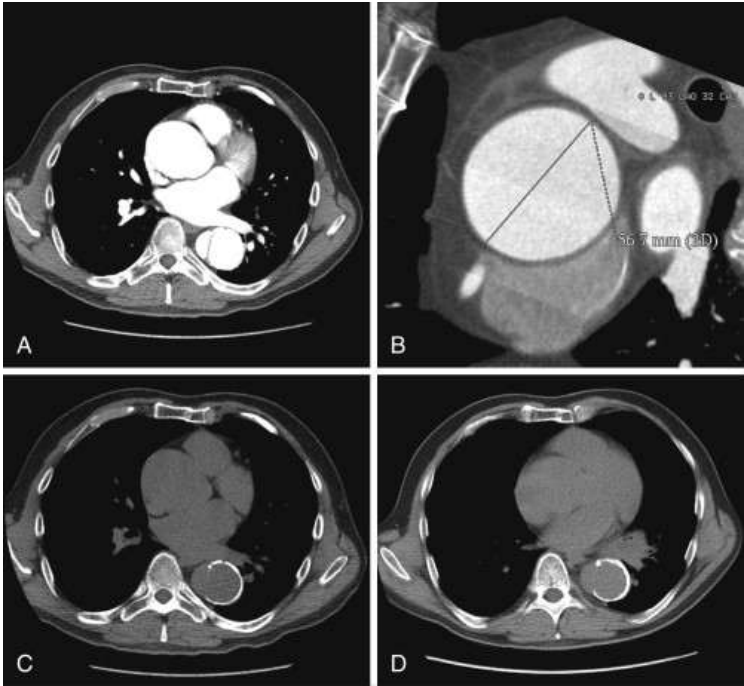


Figure 26-7
Aneurysm of the ascending aorta in chronic type B/distal dissection of the aorta. Note the extensive calcification of the free wall of the false lumen of the type B dissection, which is perfectly seen on the noncontrast images (**C** , **D**) and poorly seen on the contrast-enhanced images (**A**).

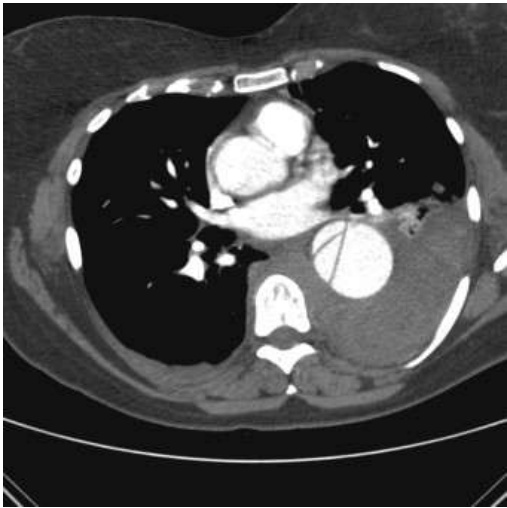


Figure 26-8
Triple lumen: a “triple-barreled” aorta due to recurrent dissection of the aorta. Note the pleural effusion, which was hemorrhagic.

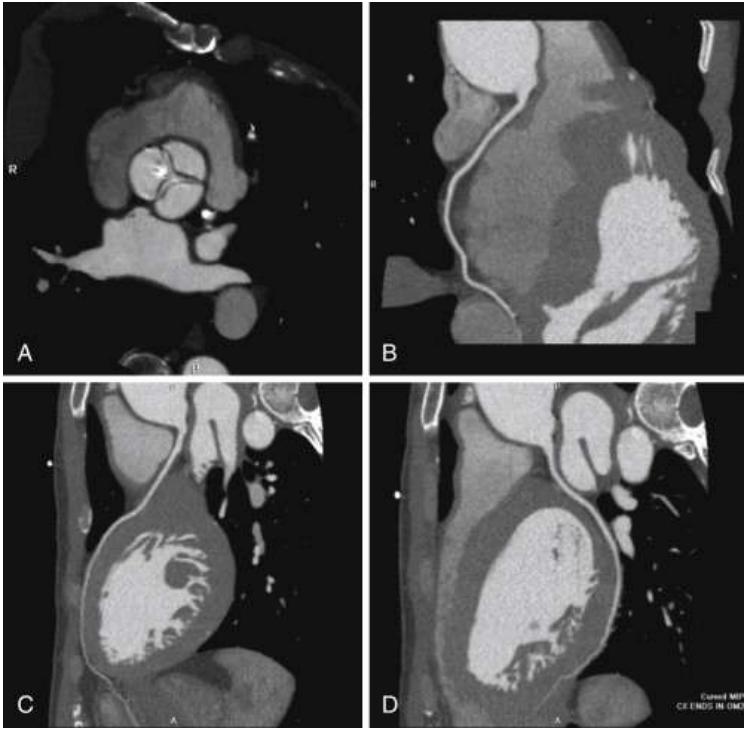


Figure 26-9
A 44-year-old man with severe aortic stenosis. This study was done preoperatively prior to aortic valve surgery to rule out any underlying significant coronary artery disease. **A**, Moderate aortic valve thickening, calcification, and restriction of the aortic valve leaflets. Curved multiplanar reformations through the right coronary artery (**B**), left anterior descending artery (**C**), and circumflex/OM1 (**D**) are normal.



Figure 26-10
An abdominal level–only type B dissection, in a patient with a family history of the same.

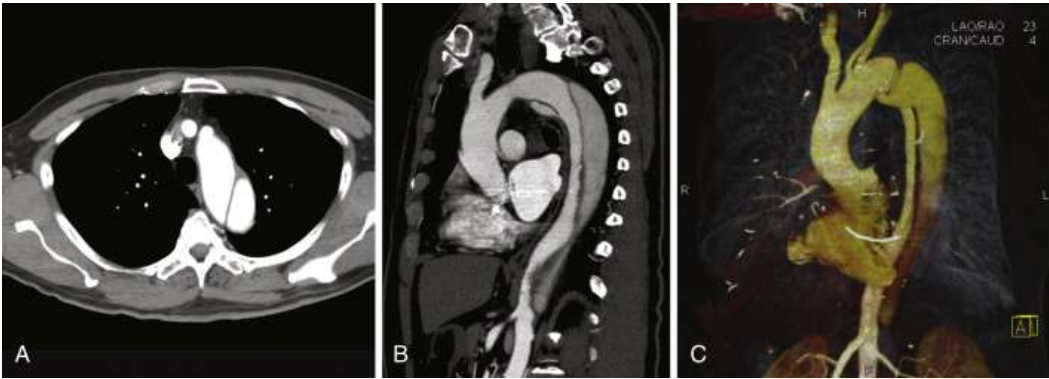


Figure 26-11
Contrast-enhanced CT aortography images of a patient with a chronic type B aortic dissection. The intimal flap is well visualized because it has become stiff and immobile.

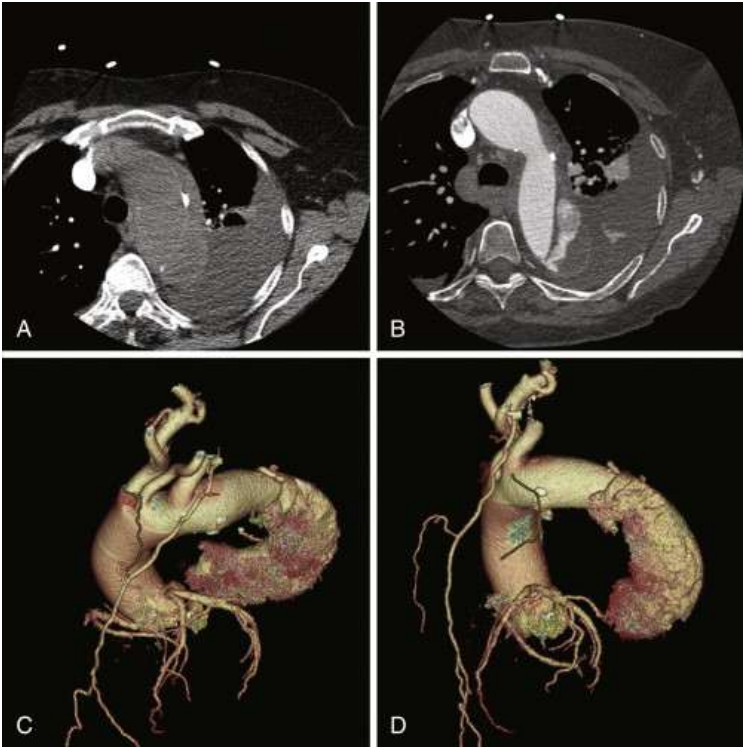


Figure 26-12
Non-contrast and contrast-enhanced CT scan images of a patient with a chronic type B aortic dissection. **A**, Non-contrast axial image reveals intimal displacement by the false lumen, marked by the inward displacement of calcified intimal plaques, and indicating either aortic dissection or intramural hematoma. **B**, Contrast-enhanced axial image at the lower arch level reveals intimal displacement, an intimal flap, an entry intimal tear in the proximal descending aorta, as well as partial thrombosis of the false lumen. **C** and **D**, Three-dimensional volume-rendered images of the irregularities of the distal false lumen. See **Video 26-1**.

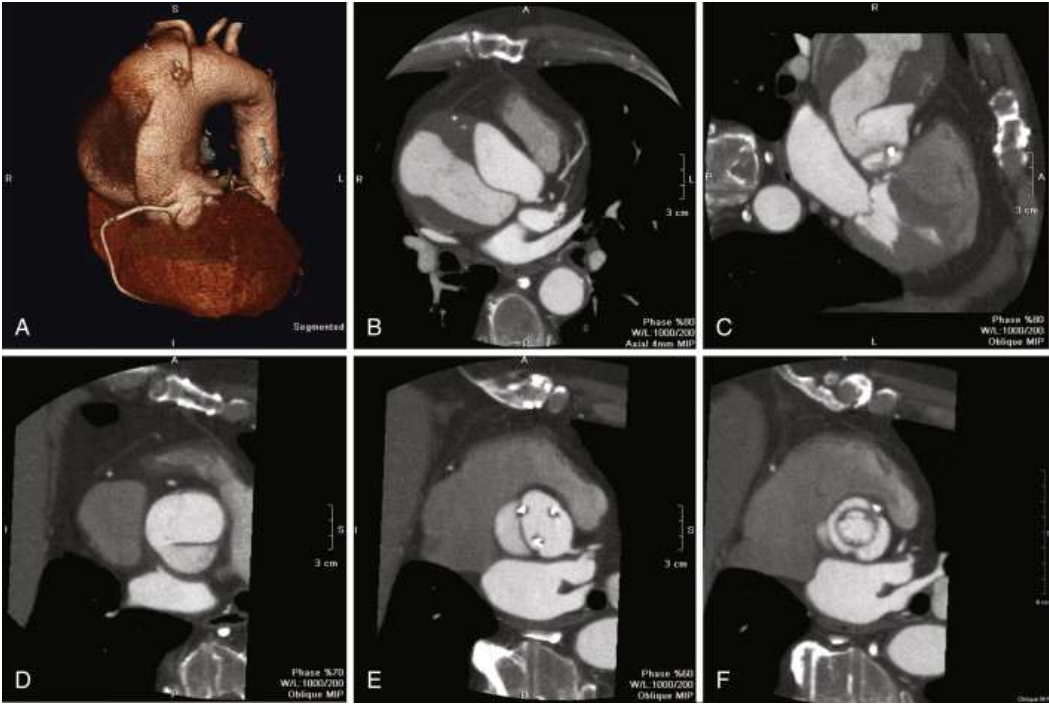


Figure 26-13
Chronic dissection of the ascending aorta in a patient with a previously inserted bioprosthetic aortic valve, whose three wire struts are apparent, as is the ring. The intimal flap is straight and clear, as is often seen with chronic dissection. There is a fair volume of thrombus within the false lumen, also consistent with chronicity. The ascending aorta is aneurysmal, and the aortic diameter normalizes only by the distal aortic arch.

Intramural Hematoma

An important variant of aortic dissection is acute intramural hematoma (IMH; [Figs. 26-14 through 26-17](#)). Approximately 10% of suspected dissection cases are IMH. Merely ruling out dissection does not achieve the diagnosis of this equally important, underrecognized pathology. There are fewer data delineating the natural history, prognostic features, and outcomes of management strategies on IMH than on AAD. To summarize what is known:

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- Outcomes parallel those of AAD.
- □ Description of the anatomic site of involvement using “Type A/Ascending” and “Type B/Descending/Non-Ascending”) as per AAD classification is suitable. The only location of IMH and AAD that does not lend itself to description by this classification is that of isolated arch involvement.
 - □ Both non–contrast- and contrast-enhanced views are useful to depict the mural thickening of IMH.
 - □ The appearance usually is of a crescentic thickening of the wall. Occasionally the mural thickening is circumferential (“annular”).
 - □ The longitudinal extent of involvement is generally much less than that of AAD (8–12 cm only). Unlike AAD, most IMH do not involve the entire aorta.
 - □ Risk appears related to:
 - • Proximal location
 - • Leakage
 - • Greater anatomic extent of involvement
 - • Association with atherosclerotic penetrating ulcer
 - □ There is no intimal tear or connection of the false lumen to the true lumen.
 - □ The differential is of aortic dissection with a thrombosed false lumen.
 - □ About 5% to 10% of cases will, in time, become frank dissection with an intimal tear connecting the true and false lumens.
 - Management is undertaken according to the paradigm of AAD management:
 - □ Surgery for proximal involvement
 - □ Medical management for uncomplicated distal involvement

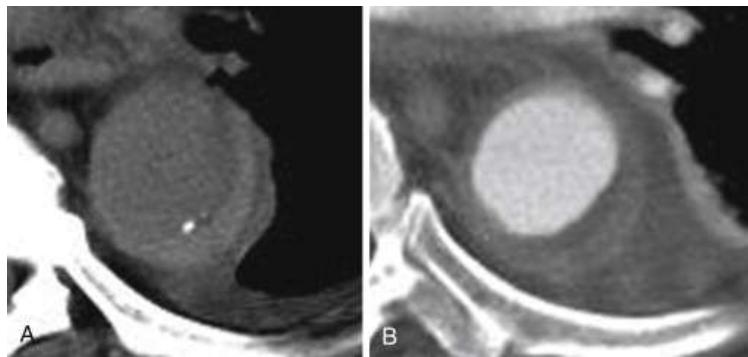


Figure 26-14
Non–contrast-enhanced (**A**) and contrast-enhanced (**B**) CT scans, at approximately the same level in a patient with intramural hematoma of the distal aorta. The noncontrast view shows posterior intimal calcification with displacement and the faint appearance of posterior crescentic wall thickening, with higher attenuation. The contrast-enhanced view effectively defines the lumen and reveals the crescentic wall thickening of the posterior aorta, but the contrast obscures visualization of the calcium.

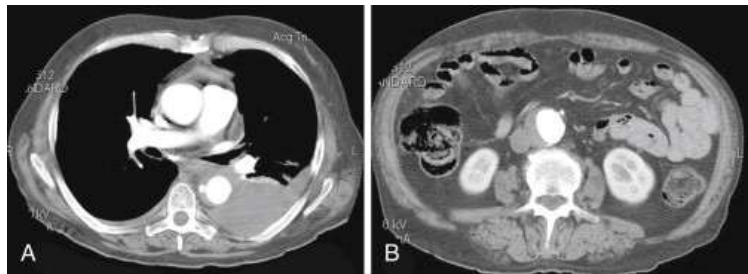


Figure 26-15
Contrast-enhanced views of the mid-thoracic (**A**) and abdominal aorta (**B**). Contrast dye within a recess in a thickened wall (**A**). The wall thickening has a uniform and non-atherosclerotic appearance and suggests intramural hematoma by its crescentic shape and even texture. This may be either a penetrating ulcer or a tear complicating the intramural hematoma.

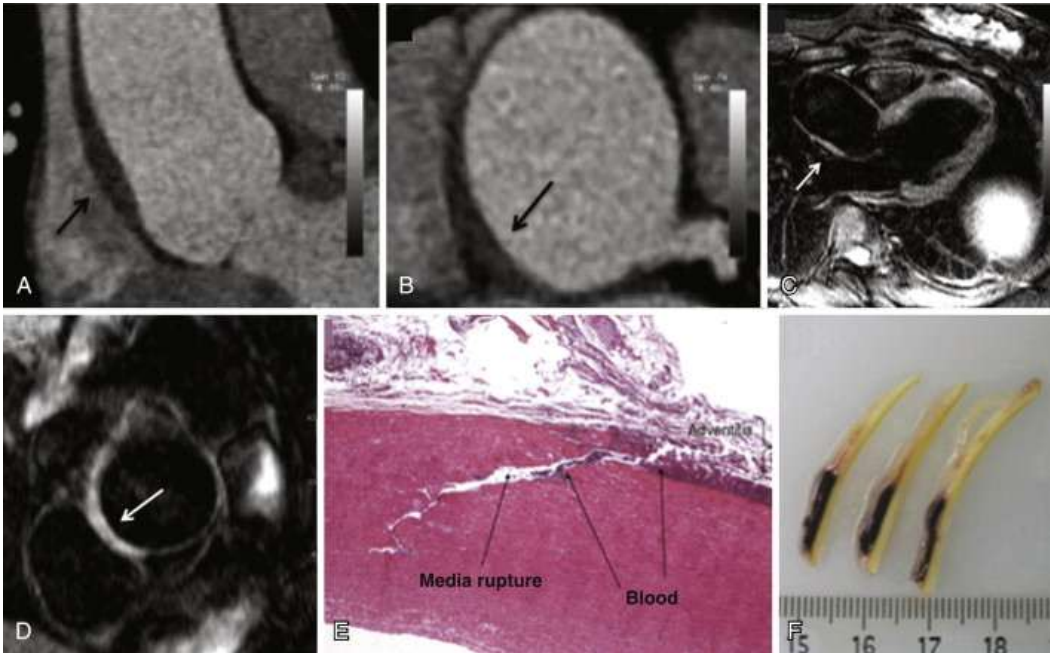


Figure 26-16
A 45-year-old woman was admitted for severe chest pain associated with sinus tachycardia. Echocardiography showed normal left ventricular function, without wall motion abnormalities, a mild aortic regurgitation, and ascending aorta dilation. Dual-source system CT showed a moderate aneurysm of the ascending aorta (46 mm) and bicuspid aortic valve. **A** and **B**, A 6-mm smooth-shaped wall thickening on the noncoronary sinus was detected, suggesting intramural aortic hematoma, without evidence of an intimal tear. **C** and **D**, MRI was performed, and the thickened aortic wall T2-weighted dark blood hypersignal confirmed the presence of fluid within the aortic wall. The patient underwent replacement of the ascending aorta and noncoronary sinus, with aortic valve sparing. **E** and **F**, Histologic examination revealed an intact intimal layer and a slender, cleftlike lesion within the outer part of the tunica media in continuous association in a larger adventitial hematoma.
(Reprinted with permission from Cavarretta E, Ramadan R, Dorfmueller P, Raoux F, Paul JF. Intramural aortic hematoma definitive diagnosis combining computed tomography and magnetic resonance imaging. *J Am Coll Cardiol*. 2011;58(16):e30.)

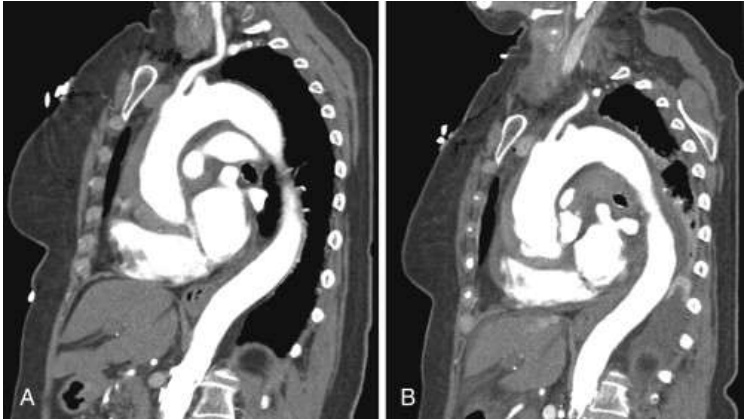


Figure 26-17
Sagittal contrast-enhanced chest CT scans of a patient with a type A intramural hematoma at presentation (**A**) and at 48 hours (**B**) with progression into a type A dissection with hemopericardium.

CT is highly accurate (100%) at identifying IMH.

The aspect of surgery that is theoretically less well suited to address IMH pathology is aortic root replacement for AAD, which has a high chance of eliminating the entry tear, thus depressurizing the false lumen distal to the root replacement and facilitating its thrombosis. In IMH, there is no entry tear to eliminate. Root replacement in the context of IMH provides protection to the aortic valve and coronary artery ostia, as well as to the pericardial space.

Identification of a penetrating ulcer responsible for IMH establishes a significantly worse prognosis. Sustained or recurrent pain, increasing left pleural effusion, increasing maximal aortic diameter, and increasing penetrating ulcer depth reliably predict progression and risk. Development of an “ulcer-like” projection of the ascending aorta or arch is a sign of progression to overt dissection.

Ulcers, Penetrating Ulcers, and Overlying Aortic Thrombus of the Aorta

The least common acute aortic syndrome is penetrating ulcer of the aorta. Atherosclerotic plaques in the aorta, as elsewhere (e.g., carotid and coronary trees), may ulcerate. Atherosclerotic plaques may eventually extend to variable depths (i.e., penetrate) within the wall of the aorta. The deeper the extent into the wall, the greater the chance of disruption of the integrity of the wall.

Weakening of the plaque that allows for communication of the lumen with deeper sections of the wall may result in propagation of blood into the wall and formation of an intramural hematoma within the wall. It also may result in leakage of blood out of the aorta (with or without an intramural hematoma), and, rarely, rupture of the aorta may occur.

CT is able to image aortic ulcers and penetrating ulcers. The challenge for all imaging modalities, including CT, is to distinguish between the two. Ulcers are common; penetrating ulcers are not. Ulcers will not lead to disruption of the aorta, whereas penetrating ulcers may do so. Ideally, imaging modalities would have sufficient resolution to depict the layers of the wall of the aorta distinct from the plaque itself. However, this is not always the case. Depiction of a deep “button-shaped” ulcer is usually convincing evidence of penetration.

Thrombi of variable size usually form on atheromatous plaques and may embolize. They commonly coexist.

Thrombosis and thromboembolism are other complications of atherosclerotic plaques of the aorta. Thrombosis is evident only on contrast-enhanced views as contrast void. A prominent plaque usually underlies the thrombus.

For images of atherosclerosis of the aorta, see [Figures 26-18 and 26-19](#) .

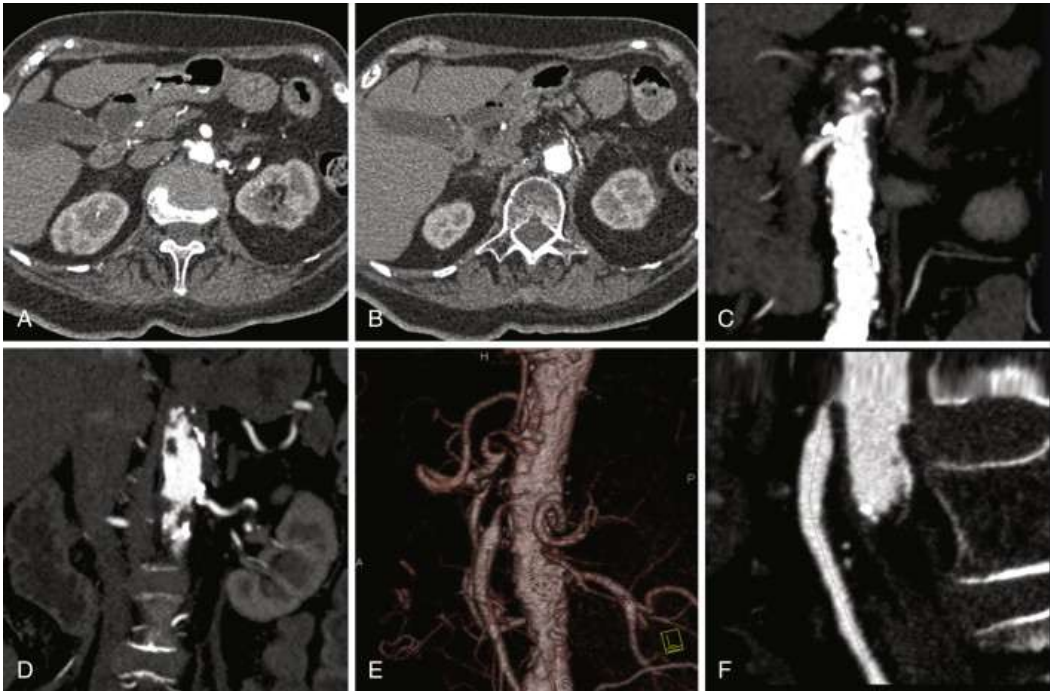


Figure 26-18
Atheromatous disease of the aorta with plaque involving the ostia to the right renal artery (**A**) and the superior mesenteric artery (**B**). Calcified plaque at the ostia to both renal arteries (**C** and **D**) and the tight stenosis of the superior mesenteric artery seen by three-dimensional reconstruction (**E**) and by “vessel extraction” (**F**).

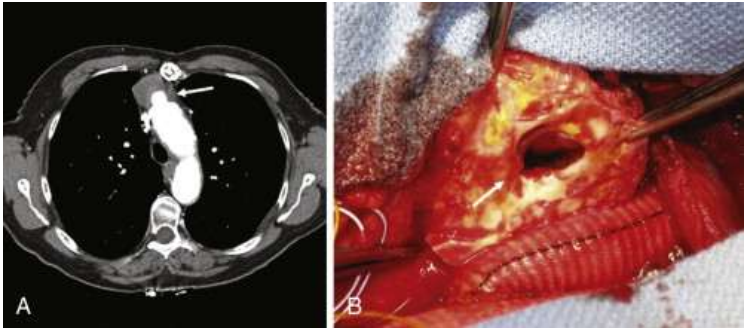


Figure 26-19
A 77-year-old woman underwent coronary artery bypass grafting in 2002. The surgeon noted a mass on the ascending aorta, adjacent to the innominate artery. He performed an off-pump coronary artery bypass grafting procedure to avoid manipulation of the aorta. The patient subsequently experienced two documented cerebral embolic events. The most recent resulted in a permanent bilateral visual field defect. Serial CT studies demonstrated progressive enlargement of a penetrating atherosclerotic ulcer of the ascending aorta adjacent to the origin of the innominate artery (**A**, *arrow*). The patient underwent excision of the penetrating ulcer (**B**, *arrow*), the ascending aorta, and the aortic arch to the level between the origins of the left carotid and innominate arteries. The ascending aorta and innominate artery were replaced with prosthetic grafts. Penetrating atherosclerotic ulcers are commonly found in the descending but rarely in the ascending thoracic aorta. Embolization from the ulcer crater was the likely cause of the cerebral embolic events.
(Reprinted with permission from Stamou SC, Kouchoukos NT. Penetrating ulcer of the ascending aorta. *J Am Coll Cardiol* 2011;57(11):1327.)

For images of atherothrombosis of the aorta, see [Figures 26-20 and 26-21](#) .

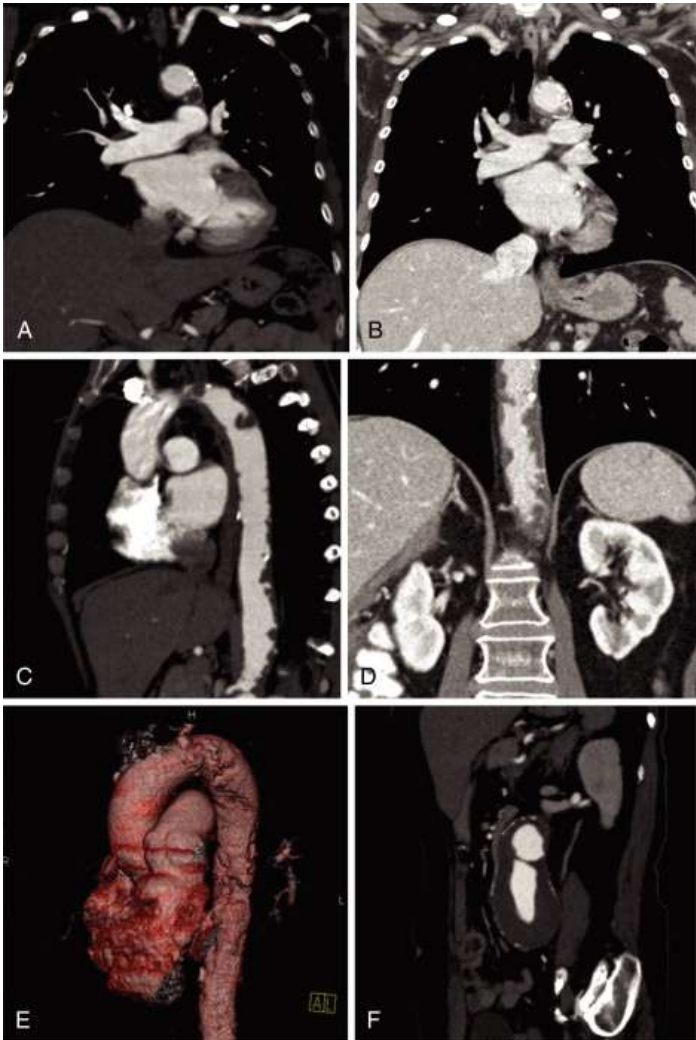


Figure 26-20
Atheromatous aorta with a penetrating ulcer of the floor of the distal arch. The upper coronal views (**A** and **B**) reveal the partially thrombus-laden penetrating ulcer extending from the floor of the distal arch. **C** and **D** , The extensive burden of protruding thrombus, and the topographically complex surface of the lumen. **E** , Three-dimensional reconstruction does provide a representation of the irregularity of the surface of the aorta, but largely fails to capture the nature of the disease as effectively as the planar views. **F** , A large abdominal aortic aneurysm in the same patient, with a large amount of mural thrombus.

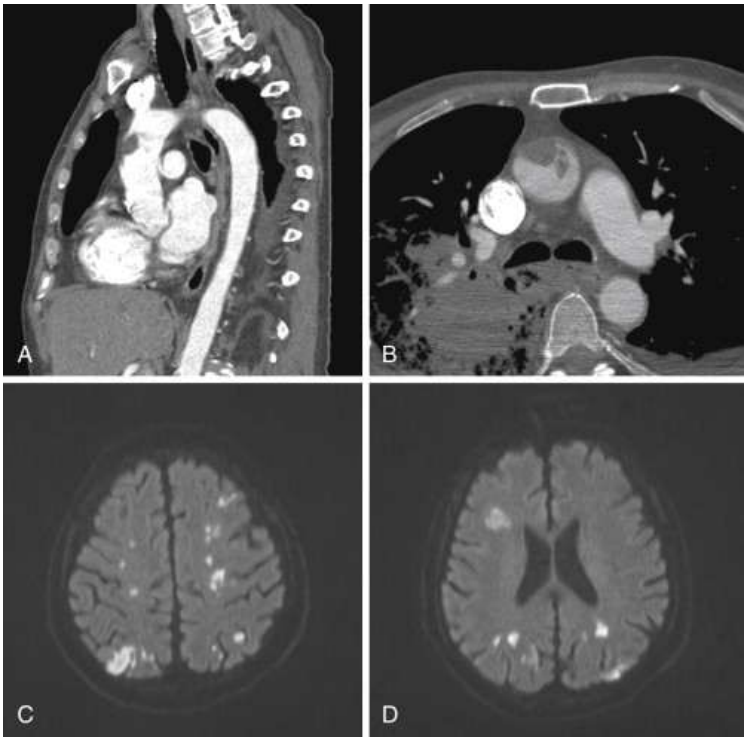


Figure 26-21
A 52-year-old man presented with strokes in dispersed territories. Diffusion-weighted MRI images (**C** , **D**). Chest CT (**C**) revealed a soft tissue mass in the ascending aorta, which was better imaged on an ECG-gated cardiac CT (**B**) to minimize motion artifact. The lesion was believed to be thrombus.

Occlusion of the Aorta

Occlusion of the aorta may be acute, resulting from either LV apical or left atrial thromboembolism, from local thrombosis often seen in low flow-shock states, from intra-aortic balloon counterpulsation, or, rarely, from more proximal aortic embolization of thrombus. Occlusion will only be apparent on contrast enhancement. Chronic occlusion usually is associated with extensive collaterals, which depend on the level of occlusion and may be caused by atherosclerosis or aortitis.

For images of occlusion of the aorta, see [Figure 26-22](#) .



Figure 26-22

Contrast-enhanced volume intensity projection image. The complete occlusion of the aorta is evident, as are extensive collaterals and reconstitution of the femoral arteries.

Middle Aortic Syndrome

“Middle aortic syndrome” is isolated abdominal level stenosis, which has many clinical similarities with coarctation of the thoracic aorta. It may be caused by aortitis.

For images of the middle aortic syndrome, see [Figure 26-23](#) .

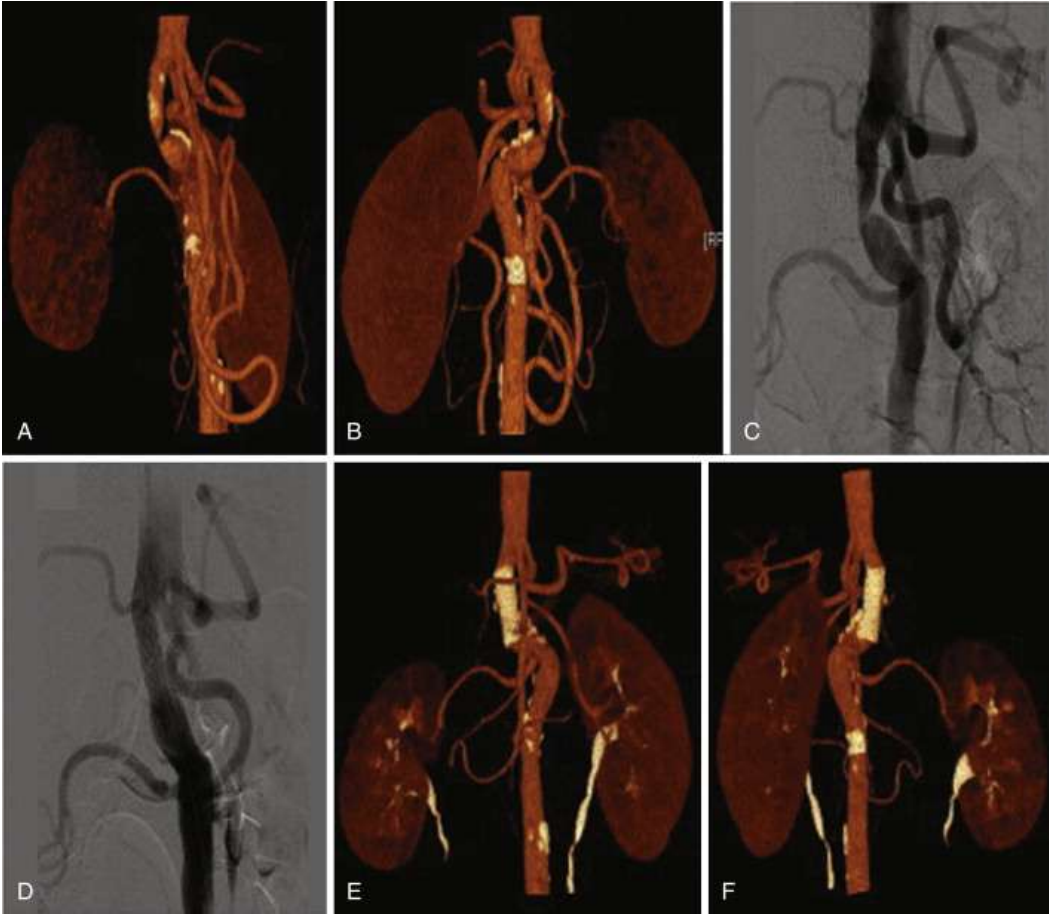


Figure 26-23

A 46-year-old woman was admitted with signs of lower limb ischemia. Her examination demonstrated a nonpalpable distal pulse. CT angiography revealed an anomalous origin of both renal arteries (**A** and **B**) and severe aortic narrowing between the renal arteries, confirmed by the angiogram (**C**). The diagnosis was middle aortic syndrome. Endovascular treatment was decided on, and a balloon-expandable covered stent (Jomed, Abbott Laboratories, Abbott Park, IL) was placed, with good stent expansion (**D**). Physical examination revealed distal pulse recovery. At 5 months, the patient remains asymptomatic. **E** and **F**, CT angiography showed stent patency. Middle aortic syndrome refers to an isolated disease of the thoracoabdominal aorta causing segmental narrowing. It often is associated with hypertension in childhood. This is a rare case of middle aortic syndrome with lower limb ischemia successfully resolved with endovascular treatment.

(Reprinted with permission from Rabellino M, Garcia-Nielsen L, Gonzalez G, Baldi S, Zander T, Maynar M. Middle aortic syndrome: percutaneous treatment with a balloon-expandable covered stent. *J Am Coll Cardiol*. 2010;56(6):521.)

Aortic Aneurysm

CT scanning is extremely well suited to diagnosing and assessing aneurysmal disease of the aorta: thoracic, abdominal and thoracoabdominal ([Figs. 26-24 through 26-30](#)). CT scanning is able to:

- ☐ Identify aneurysms
- ☐ Establish anatomic extent
- ☐ Establish (accurately) aneurysm diameter

- ☐ Distinguish aneurysms from dissection and false aneurysm
- ☐ Identify mural thrombus within aneurysms
- ☐ Identify leakage
- ☐ Identify the relation of the aneurysm to branch vessels
- ☐ Establish interventional suitability and planning
- ☐ Establish the relation of aneurysms of the aortic root and sinuses to coronary arteries



Figure 26-24
Contrast-enhanced image just below the renal arteries in a patient with a ruptured abdominal aortic aneurysm. There is a large abdominal aortic aneurysm with extensive thrombus and multiple channels through it. The hazy streaking around the abdominal aorta is consistent with extravasated blood.

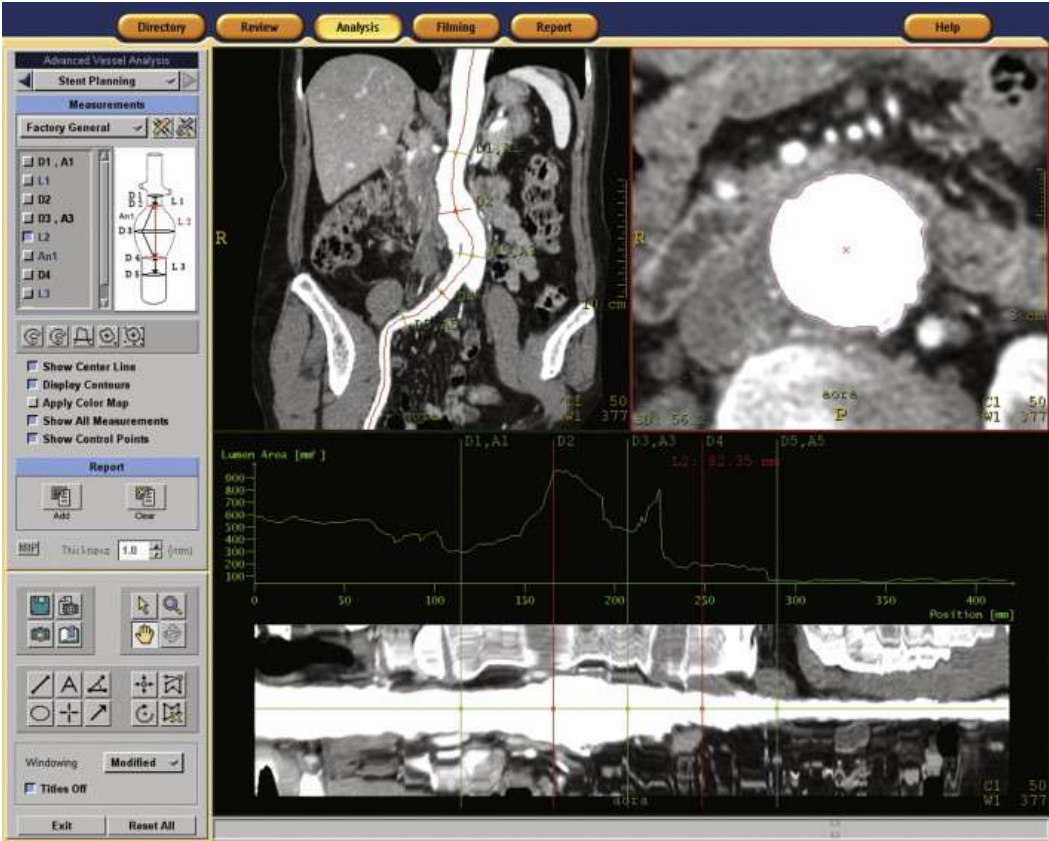


Figure 26-25
Endovascular aneurysm repair planning workstation software. The three displays—multiplanar, orthogonally oriented image to the long axis of the “seeded” vessel, and “vessel extracted” display—are integrated. Diameters for the proximal and distal landing zones of a stent, and its limbs, are being measured for planning.

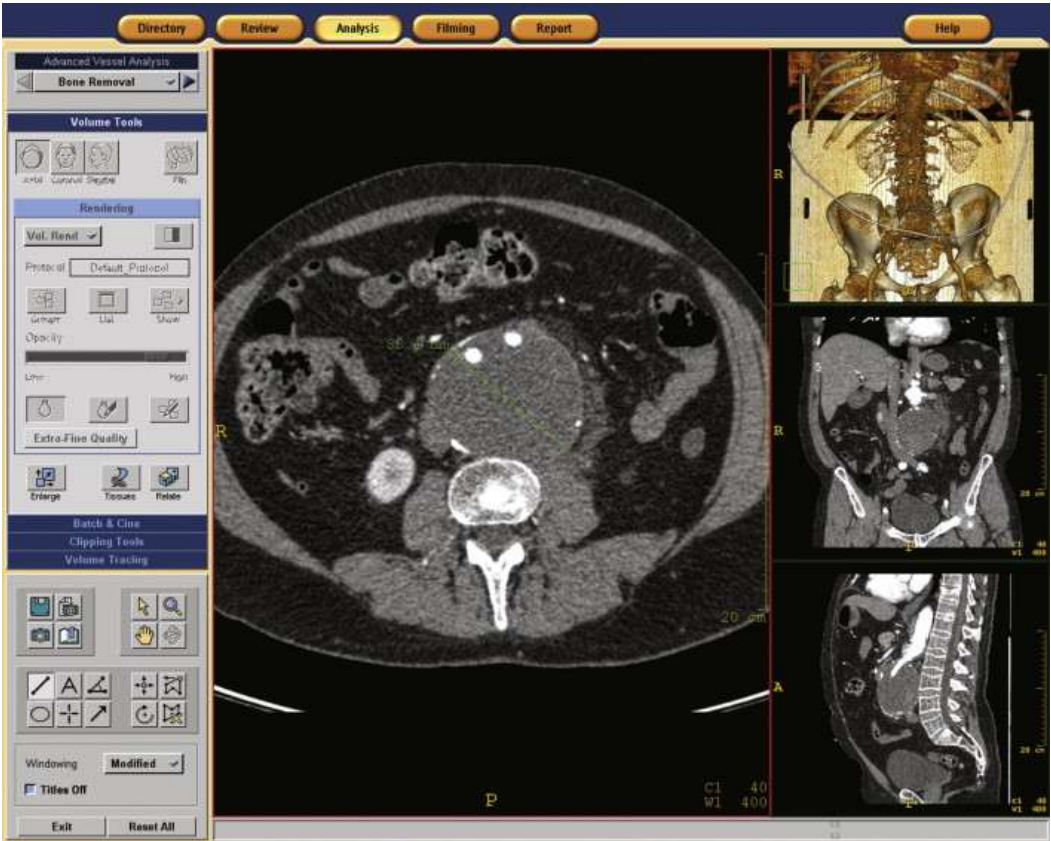


Figure 26-26
Contrast-enhanced workstation images of the abdominal aorta. The limbs of the stent are seen. There is no endoleak.

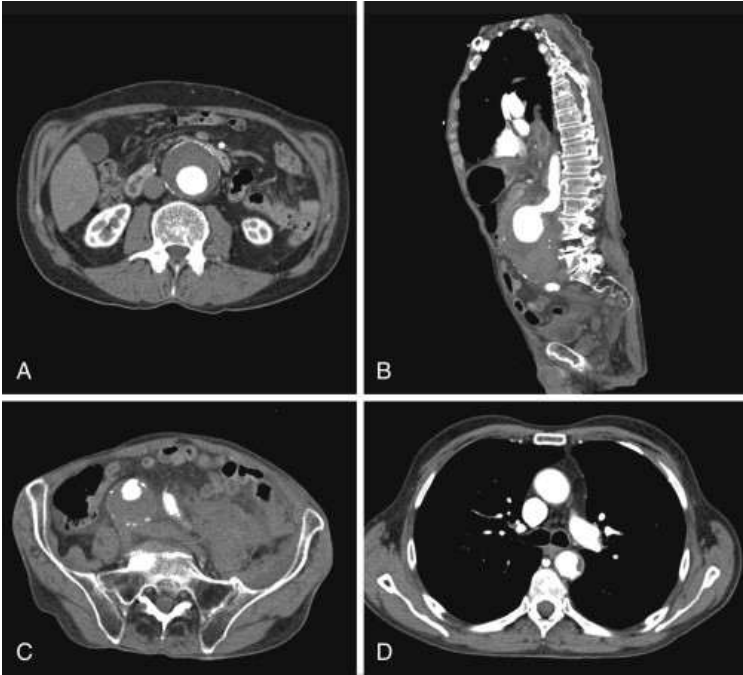


Figure 26-27
A and **B**, Large infrarenal abdominal aortic aneurysm with eggshell calcification and a large amount of mural thrombus. **C**, An associated large aneurysm of the right common iliac artery, also with eggshell calcification and a large amount of mural thrombus. The left common iliac artery, adjacent to it, serves as a reference standard. **D**, Associated atheromatous disease of the upper thoracic descending aorta, also with mural thrombus.

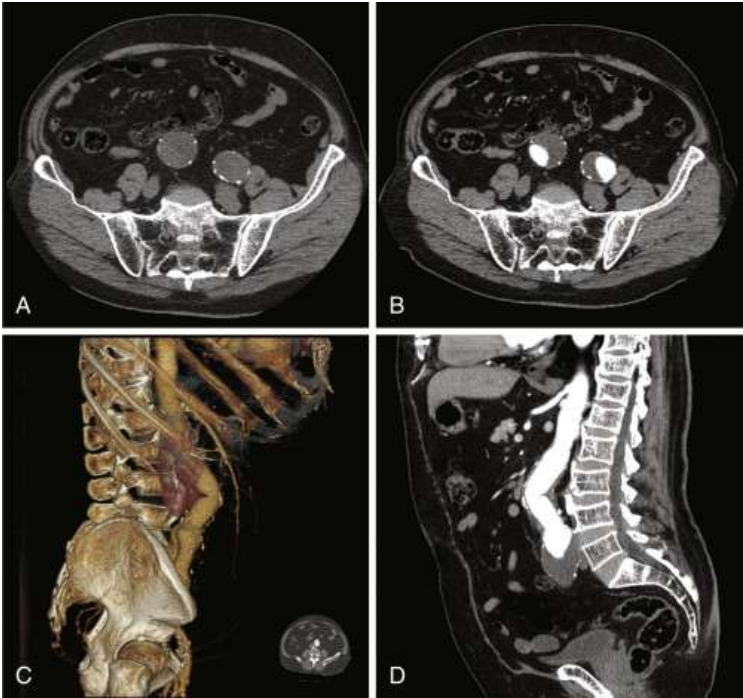


Figure 26-28
Axial CT images at the common iliac level without contrast (**A**) and with contrast (**B**). Volume-rendered reconstruction (**C**) and sagittal view (**D**). There is a small fold along the posterior wall of the graft that is more a folding than a kinking of the graft.

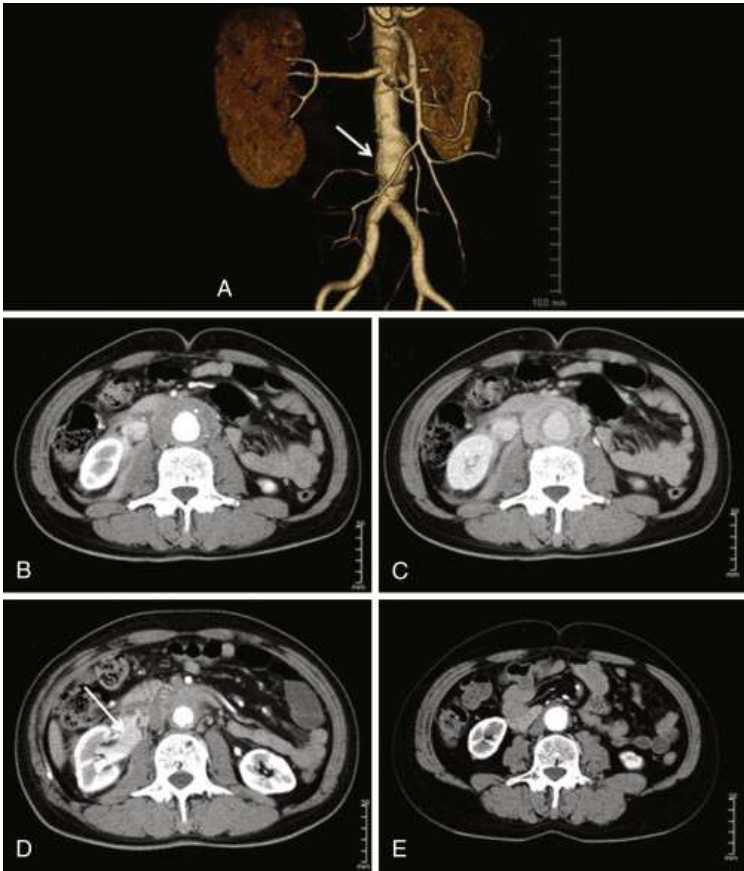


Figure 26-29

A 60-year-old man presented with low back pain. Laboratory examination revealed a raised erythrocyte sedimentation rate of 83 mm/hr, an elevated C-reactive protein of 3.9 mg/dL, and estimated glomerular filtration rate of 36 mL/min/m². A CT scan showed a 4.0-cm infrarenal abdominal aortic aneurysm (three-dimensional volume-rendered contrast-enhanced image [**A**]) with extremely thickened aortic wall and surrounding soft tissue mass (**B**). The periaortic mass appears as isodense to muscle and enhances circumferentially with administration of contrast medium, indicating it is in active inflammatory stage (**C**). As a result of inflammatory tissue enveloping the right ureter, the right kidney showed ureterohydronephrosis (**D**). To control the perianeurysmal inflammation, corticosteroid therapy was started with prednisolone at an initial dose of 30 mg/day, which was gradually reduced to a maintenance dose of 2.5 mg/day, based on the improvement of inflammatory signs as well as change in size of the retroperitoneal mass. Six months later, a CT scan demonstrated marked regression of the retroperitoneal mass and thickened aortic wall (**E**) and resolution of the ureteral obstruction. The patient is doing well at 4 years of follow-up. (Reprinted with permission from Yabe T, Hamada T, Kubo T, et al. Inflammatory abdominal aortic aneurysm successfully treated with steroid therapy. *J Am Coll Cardiol*. 2010;55(25):2877.)

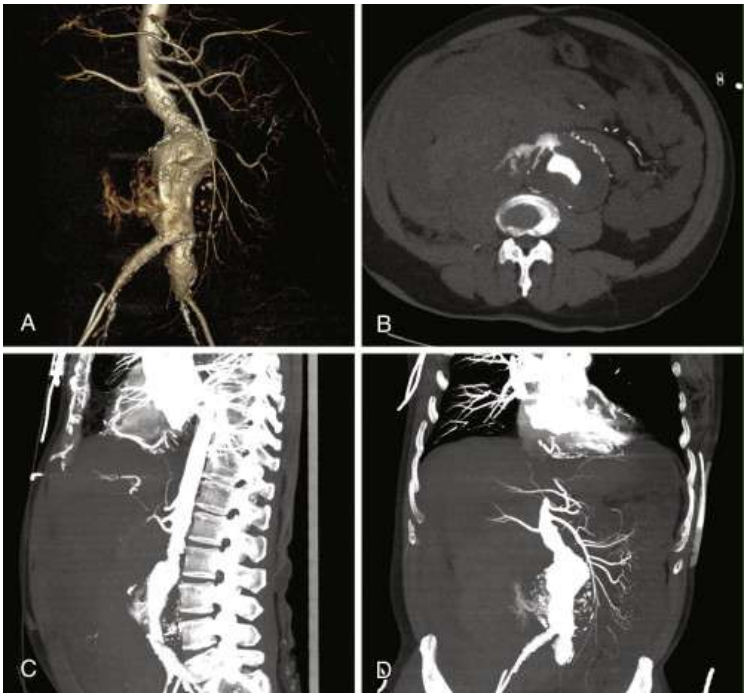


Figure 26-30

Multiple volume-rendered and maximum intensity projection images from an 82-year-old man who presented to the emergency department with abdominal pain. A large infrarenal abdominal aortic aneurysm is appreciated. These CT angiographic images demonstrate a focal area of leakage of contrast outside the confines of the abdominal aorta. Extensive retroperitoneal and intraperitoneal fluid is present. These findings are typical of acute rupture of an abdominal aortic aneurysm.

Contrast (catheter-based) aortography offers little additional information to CT scanning since CT can perform multiplanar imaging.

CCT is better suited to determining the anatomic extent of aortic aneurysm than is aortography. Older studies suggest that in the claudicant patient with aortic aneurysms, aortography retains a role for determination of iliac stenosis or obstruction ; studies using newer systems have yet to follow up on this.

Thoracic Aortic Aneurysms

For images of thoracic aortic aneurysms, see [Figures 26-31 through 26-39](#) .

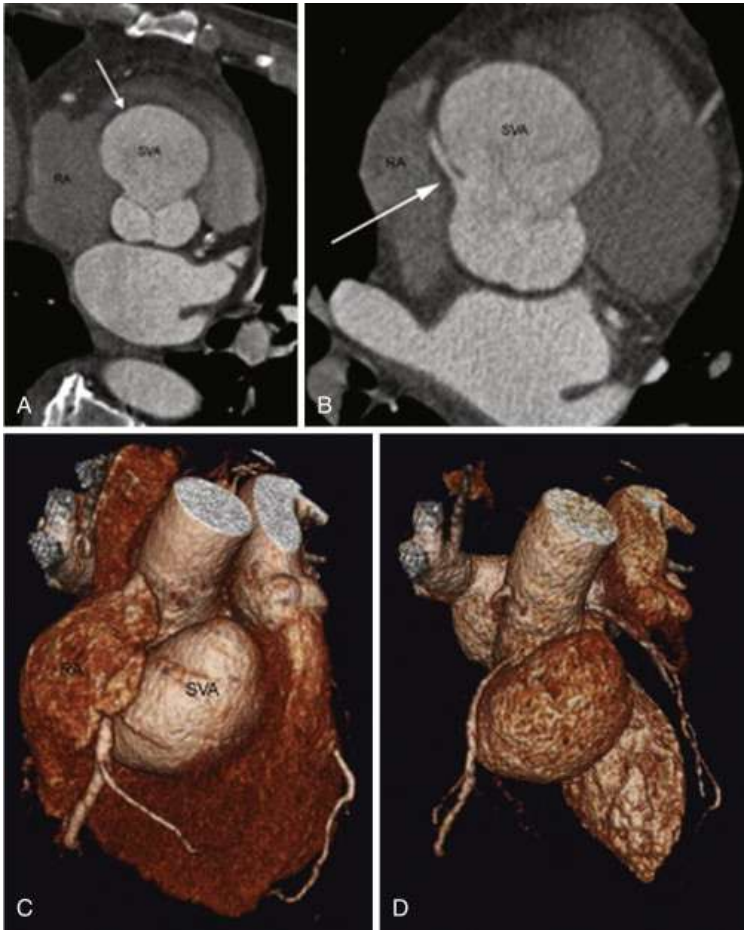


Figure 26-31
A, This CT axial oblique image shows a sinus of Valsalva aneurysm (*white arrow*). **B**, The CT axial image shows compression of the proximal right coronary artery (*white arrow*) between the sinus of Valsalva aneurysm (SVA) and the right atrium (RA). **C**, CT volume-rendered reconstruction again shows compression of the right coronary artery between the SVA and the RA. **D**, The CT volume-rendered reconstruction shows an SVA.
(Reprinted with permission from Joines M, Barack BM, Chang DS. Right coronary sinus of Valsalva aneurysm evaluated by cardiac computed tomography angiography. *J Cardiovasc Comput Tomogr*. 2008;2(3):193-194.)

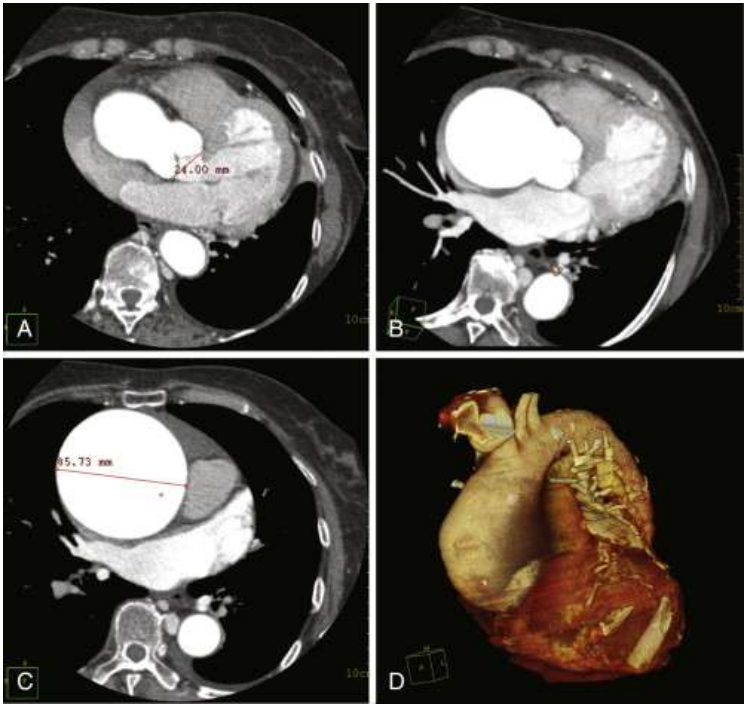


Figure 26-32
Contrast-enhanced axial and three-dimensional volume-rendered views of a large aneurysm, without dissection, involving the ascending aorta. The sinotubular junction and sinuses are normal. **A**, Aortic valve annulus, **B**, Maximal diameter of the ascending aorta,



Figure 26-33
Contrast-enhanced image at the aortic arch level. There is a saccular extension of the lumen into a thrombus-filled cavity. This was a largely thrombosed false aneurysm, which subsequently ruptured.

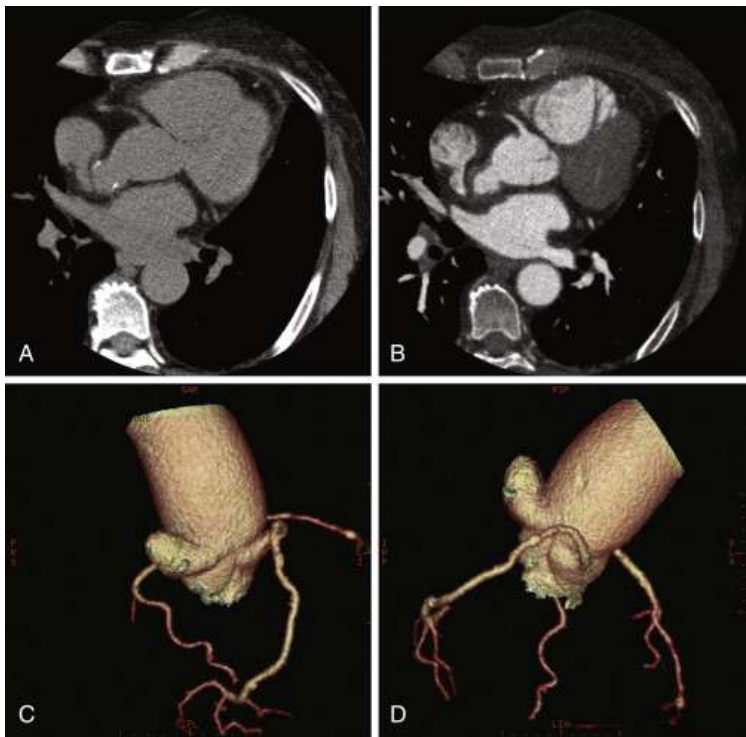


Figure 26-34
A, Non-contrast-enhanced axial image reveals an abnormal contour off the right posterior aortic root, with calcification. **B**, This contrast-enhanced axial source image demonstrates a small saccular aneurysm extending from the right posterior aortic root, with either a thick wall or a rind of mural thrombus. **C** and **D**, Three-dimensional volume-rendered images depict the small saccular aneurysm, the length of which is greater than its diameter, and which arises at the sinotubular junction.

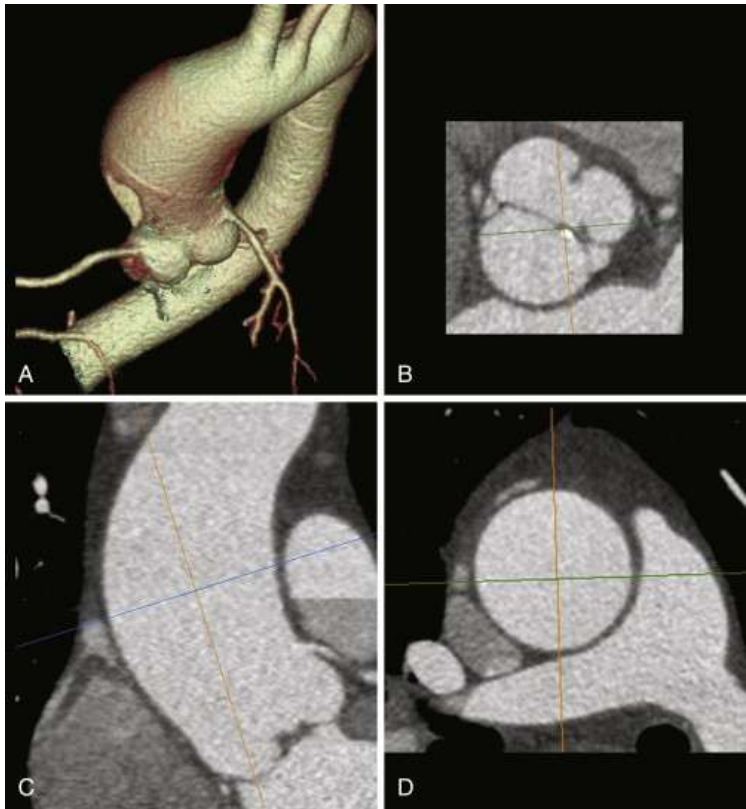


Figure 26-35
Multiple images from a cardiac CT study. A functional bicuspid aortic valve is noted with a partial raphe between the right and left coronary cusps. There is mild thickening of the aortic valve leaflets, and a small focus of calcification involving the valve leaflets. As the study was obtained prospectively, evaluation of aortic valve function is not possible. There is an associated ascending aortopathy. **C** and **D**, Double oblique evaluation of the ascending aorta demonstrated an ascending aortic aneurysm of 4.8 cm. There was no evidence of an occult dissection or of coarctation.

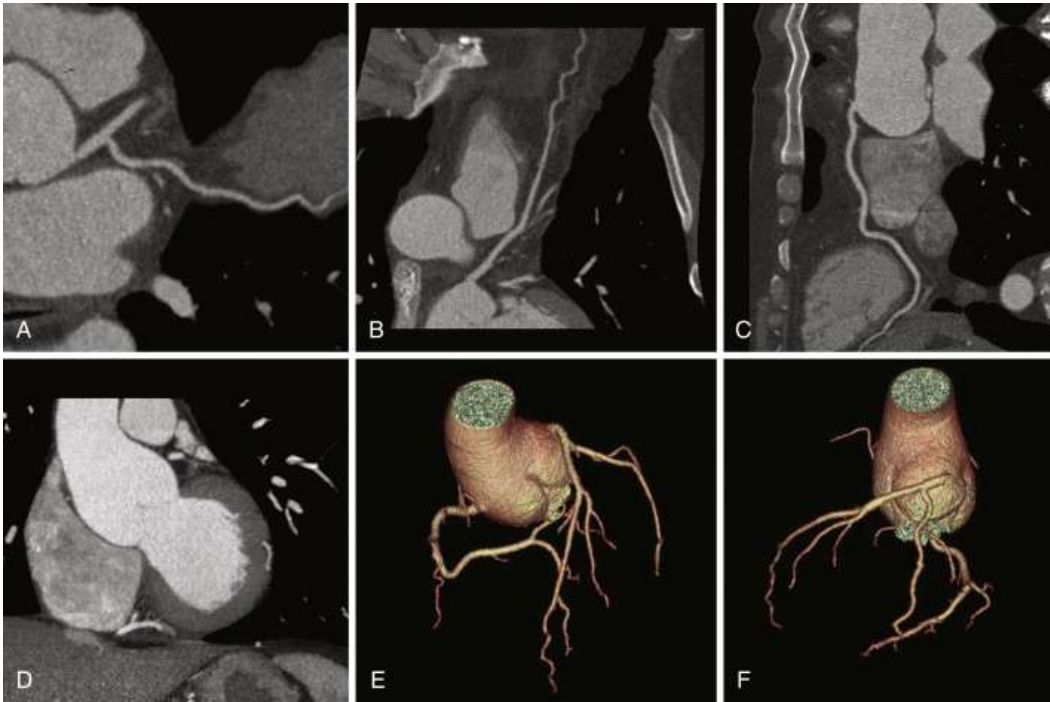


Figure 26-36
Multiple images from a cardiac CT study in a patient with known Marfan syndrome. This study was performed preoperatively to evaluate coronary arteries. The obtuse marginal/circumflex system (**A**), left anterior descending artery (**B**), and right coronary artery (**C**) are normal in appearance. The aortic root has a typical tulip bulb–like configuration as is commonly described in the setting of Marfan syndrome. The aorta at the level of the mid sinuses of Valsalva measures 5.4 cm, aneurysmal.

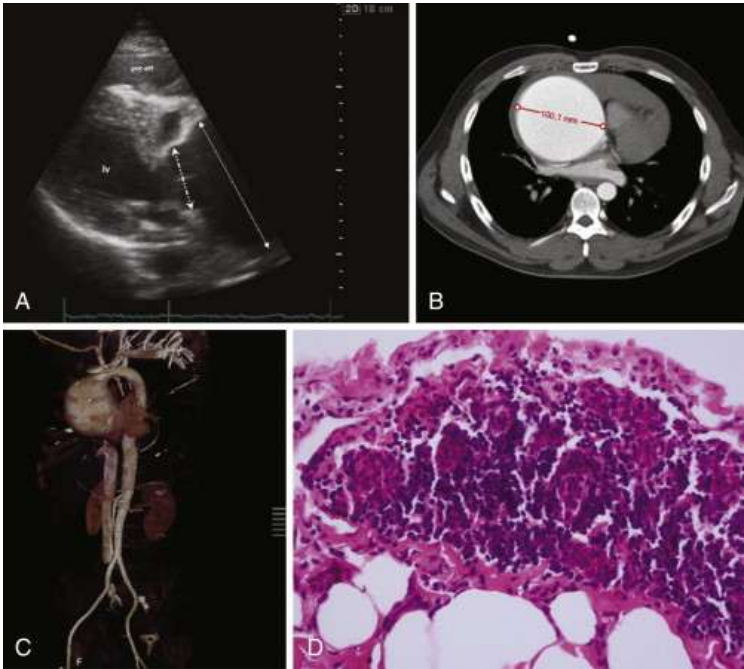


Figure 26-37
A previously healthy 38-year-old man presented with sudden-onset dyspnea, sharp, stabbing chest pain, and a clinical picture of cardiogenic shock. **A**, Echocardiography revealed a severely dilated ascending aorta beyond the sinotubular junction, with moderate aortic insufficiency. There was a large pericardial effusion with thrombus inside. CT angiography was performed, with a presumptive diagnosis of aortic dissection with rupture into the pericardium, and demonstrated a dilated ascending aorta 100 mm in diameter (**B** and **C**) compressing the right atrium, with no visible intimal tear or flap. The patient underwent an emergent Benthal procedure. Intraoperatively, no intimal tear or dissection was noted. Pathology revealed predominantly lymphoplasmacytic inflammatory cell infiltrates around the vaso vasorum of the adventitia (**D**) in the resected aortic segment, suggesting that tamponade resulted from tearing of the adventitial vessels. Blood work was positive for *Treponema pallidum* hemagglutination antibody. A diagnosis of tertiary syphilis complicated by aortic aneurysm was made. (Reprinted with permission from Acar Z, Agac MT, Demirbas M, Kurt D. Giant syphilitic aortic aneurysm presenting with pericardial tamponade as an initial sign. *J Am Coll Cardiol*. 2012;59(1):e1.)

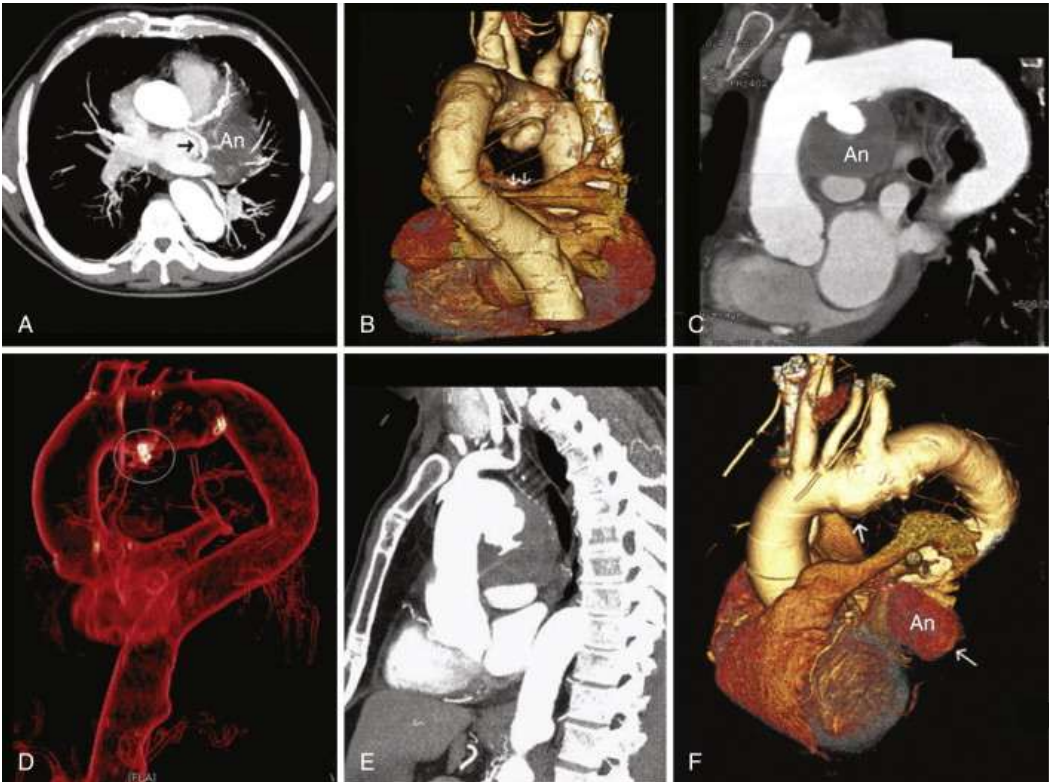


Figure 26-38
A 62-year-old man with arteriopathy and chronic obstructive pulmonary disease, coronary aneurysm, and an aortic false aneurysm. **A**, CT scan in transverse section shows a large circumflex coronary aneurysm (arrow) following covered stent closure of the entry. Diffuse coronary disease is apparent in the left anterior descending branch. **B**, CT reconstruction demonstrates the nonthrombosed part of a 6.5-cm saccular arch aneurysm compressing the pulmonary bifurcation (double arrow). **C**, A lateral view shows the partially thrombosed arch aneurysm. **D**, CT reconstruction with the Amplatzer occluder device closing the mouth of the aneurysm. **E**, A lateral view (1 year later) shows that the neck of the aneurysm has increased in size. The device has prolapsed into the sac with further pulmonary artery compression. **F**, CT reconstruction shows the repaired ascending aorta (arrow) and arch together with the thrombosed circumflex coronary aneurysm (arrow). An, aneurysm.
(Reprinted with permission from Westaby W, Luthra S, Anthony S, Ormerod O, Wilson N, Amplatzer device deployment for saccular aortic arch aneurysm. A note of caution. *Circulation*. 2012;125:1318-1320.)

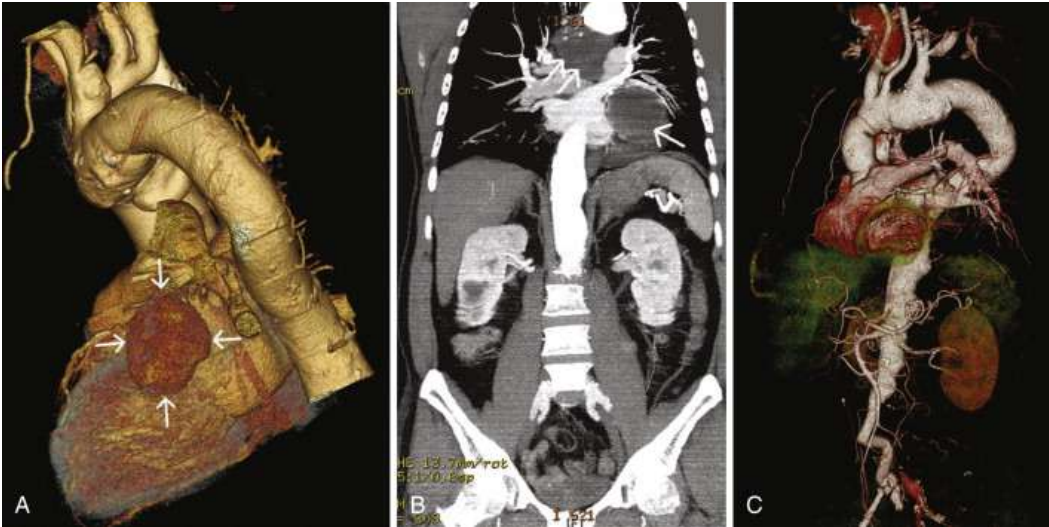


Figure 26-39
A and **B**, A 62-year-old man with arteriopathy and chronic obstructive pulmonary disease, coronary aneurysm, and an aortic false aneurysm. **A**, CT reconstruction, lateral view, defines the morphology of the circumflex aneurysm before intervention (arrows). **B**, CT scan shows both the saccular arch (single arrow) and the circumflex aneurysms (double arrow s) in coronal profile. **C**, CT reconstruction of a recent follow-up scan showing the whole aorta, including the aorto-bifemoral graft with occlusion of one limb. There is no significant compression of the pulmonary artery and no flow into the excluded saccular aneurysm.
(Reprinted with permission from Westaby S, Luthra S, Anthony S, Ormerod O, Wilson N, Amplatzer device deployment for saccular aortic arch aneurysm. A note of caution. *Circulation*. 2012;125:1318-1320.)

Arch Vessel Aneurysms

Arch vessel aneurysms may be congenital, may arise from an aberrant right subclavian artery (diverticulum of Kommerell), or may be associated with a thoracic outlet syndrome, post-traumatic false aneurysm, infection, atherosclerosis, or even Takayasu disease. Most arch vessel aneurysms are asymptomatic until complications arise or may be detected as an incidental finding on a plain radiograph.

Mycotic Aneurysms

Mycotic aneurysm is a rare clinical entity with an incidence of 0.8% to 3.4% of all aortic aneurysms. Virtually any artery may be involved. In the pre-antibiotic era, most mycotic aneurysms were secondary to valvular disease. Today approximately 80% result from either circulating bacteria implanting in diseased atherosclerotic or traumatized intima or secondary to direct extension or through lymphatic vessels from a nearby infection. Additionally, infection of a pre-existing aneurysm can occur. Risk factors include arterial catheterization, intravenous drug abuse, concurrent sepsis, or immunocompromised states. The mean age at presentation is the seventh decade. The predominant organisms are *Staphylococcus aureus* and *Salmonella* species. Presentation may be of pyrexia of unknown origin, and diagnosis rests on a high index of suspicion. Lobular, saccular, or eccentric aneurysms can occur, which on MRI appear as small outpouches of signal void along the lateral walls of the vessel, often accompanied by periaortic soft tissue. Enlargement of the vessel lumen eventually develops, usually in a time span between 10 days and 3 months. Progression of a normal vessel to a markedly dilated and thinned one may be very rapid.

Coarctation of the Aorta

Anatomic coarctation of the aorta is well depicted by CT scanning, but the physiologic disturbance (gradient) is not. CT scanning is able to depict:

- □ The location and longitudinal extent of the coarctation

- □ Associated features such as:
 - • Dilation or aneurysm of the ascending aorta
 - • Associated bicuspid aortic valves
 - • Dissection of the proximal or distal aorta
 - • Patent ductus arteriosus
 - • Collateral vessels
 - • Intracranial “berry” aneurysms

The gradient across the coarctation can be assessed by a hybrid strategy using echocardiography, or an alternate imaging strategy using MRI to obtain the gradient.

Diameter measurements are subject to some variability, and serial comparisons should be interpreted with caution. The same appears to be true for MRI measurements.

Maximum intensity projection images are useful for assessing coarctation, as are three-dimensional views.

For images of coarctation of the aorta, see [Figures 26-40 through 26-50](#) and [Video 26-2](#) .

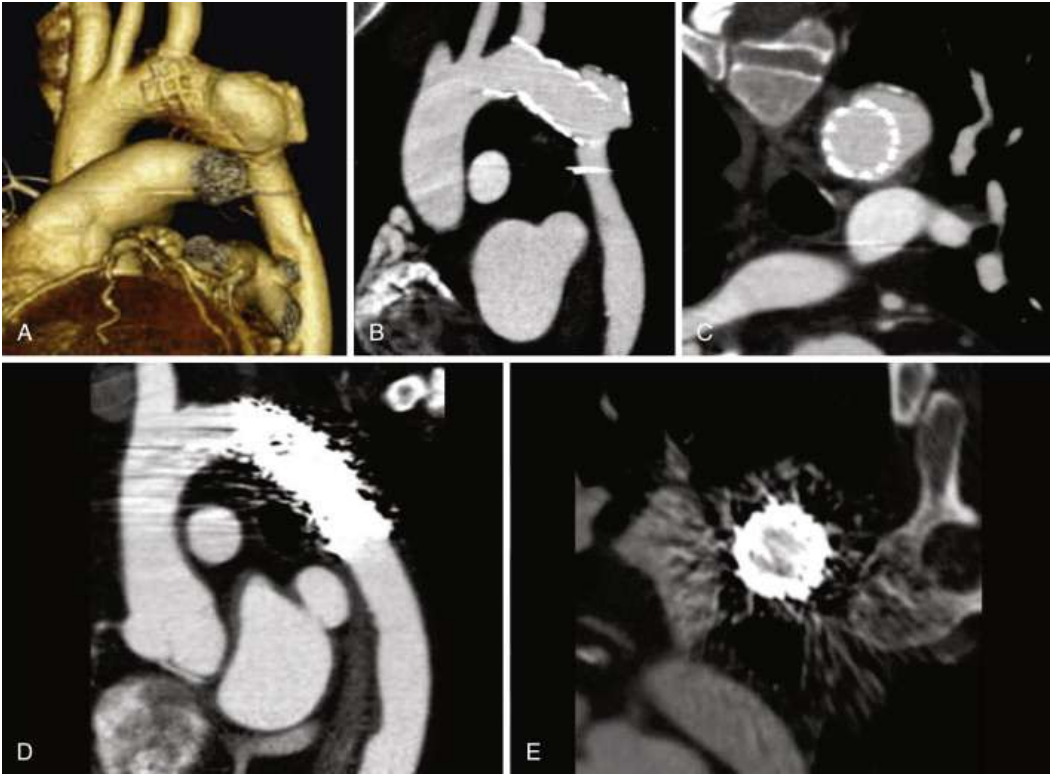


Figure 26-40
Multiple images from two separate cardiac CT studies. **B** and **C**, A cardiac CT study post–bare metal stenting for coarctation of the aorta. This study and subsequent imaging demonstrate a growing pseudoaneurysm with contrast collecting outside the confines of the stent. Repeat imaging with placement of an internal covered stent demonstrates subsequent thrombosis of the false aneurysm with no residual extravasation of contrast.

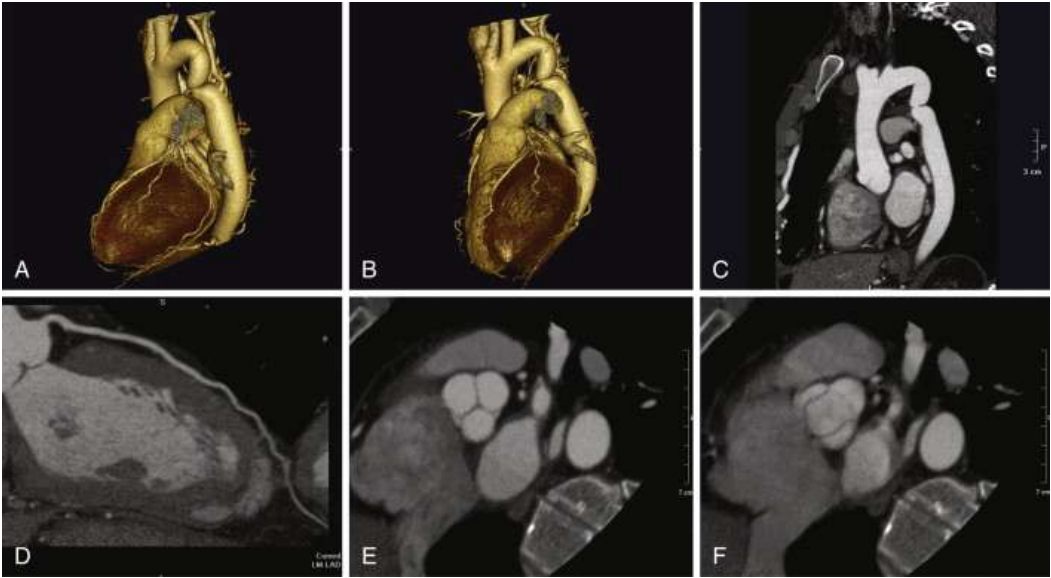


Figure 26-41

Composite images from a cardiac CT study demonstrate a tight shelf-like coarctation in the proximal descending thoracic aorta. Normal coronary arteries were identified, and a functionally bicuspid aortic valve is present.

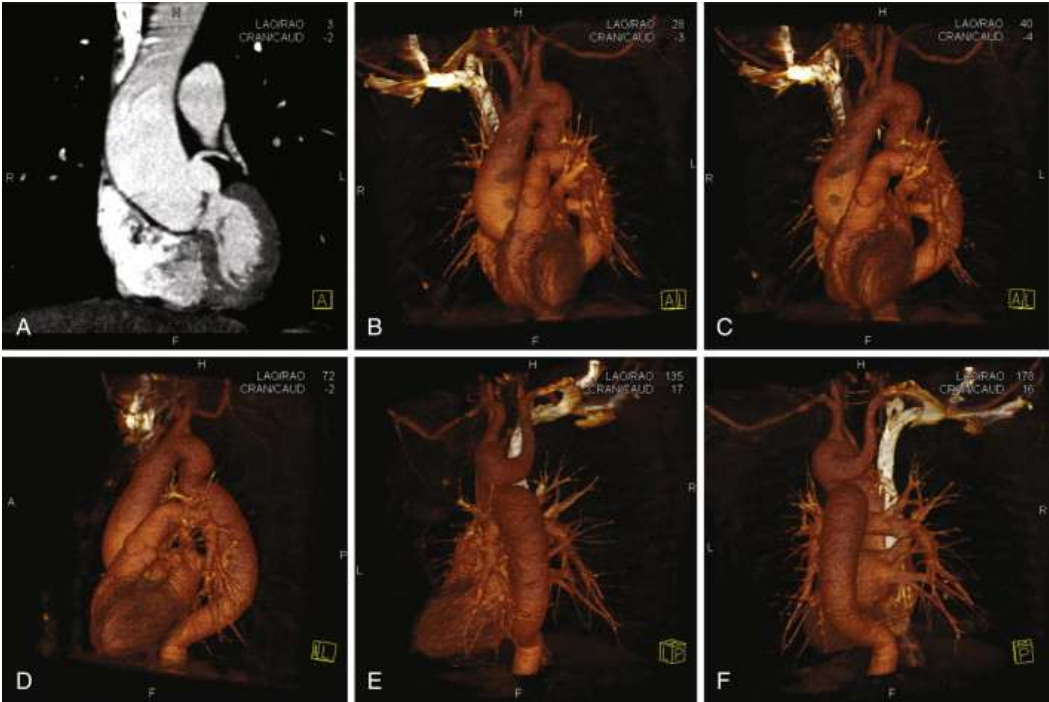


Figure 26-42

Planar and three-dimensional reconstructions (with varied projections) depict dilation of the aortic root and ascending aorta (associated with a bicuspid aortic valve), a mild narrowing (30 mm Hg gradient) at the site of a previously repaired coarctation, tortuosity at the site of repair, and dilation of the ongoing descending aorta, both before and after the repaired coarctation.



Figure 26-43

A 37-year-old man presented with resistant hypertension on four drugs. The physical examination revealed radiofemoral delay and clinical left ventricular hypertrophy. **A** and **B**, Very distinct palpable pulsatile collateral vessels were discovered over his left scapular, left chest wall, and anterior abdominal wall. Echocardiography confirmed left ventricular hypertrophy with good systolic function and a normal left ventricular outflow tract. Suprasternal echocardiography revealed a stenosis in the descending aorta (**C**) with a peak systolic gradient of 84 mm Hg and a pan-diastolic gradient (**D**). **E** and **F**, A 64-mm CT scan of the chest revealed a focal coarctation and collaterals extending over the scapular and over the anterior abdominal wall. The patient decided to consider his options of surgical correction versus an endovascular stent.

(Reprinted with permission from Peters F, Essop R. Coarctation of the aorta with visible palpable collaterals over the scapular and anterior abdominal wall. *J Am Coll Cardiol*. 2010;56(5):423.)

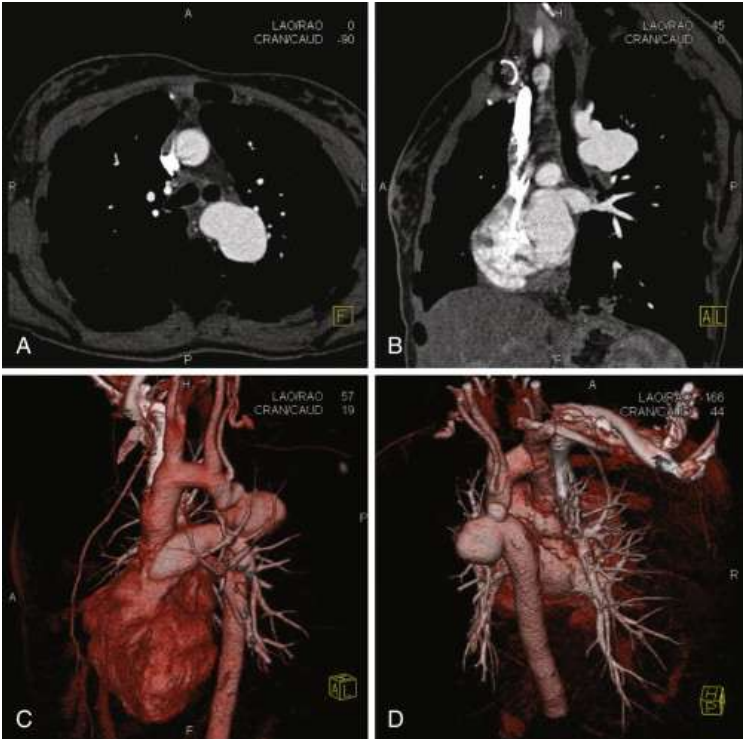


Figure 26-44

Axial, oblique, and three-dimensional reconstructions of an aneurysm/false aneurysm at the site of a remotely repaired coarctation. The absence of the proximal left subclavian artery strongly suggests that it was used to repair the coarctation.

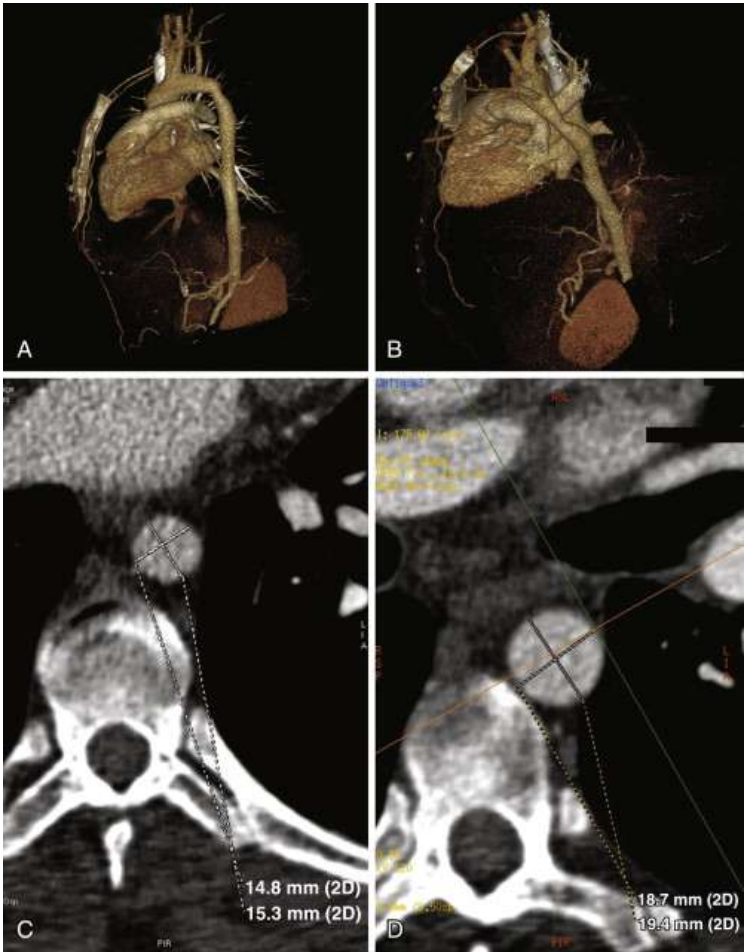


Figure 26-45

Volume-rendered (**A** and **B**) and axial source images (**C** and **D**) from a gated CT angiogram of the chest in a patient with a prior history of coarctation and previous end-to-end surgical repair. The volume-rendered images demonstrate a mild recoarctation at the surgical site. There is focal dilatation of the proximal descending aorta distal to the coarctation site, which may represent some mild poststenotic dilatation

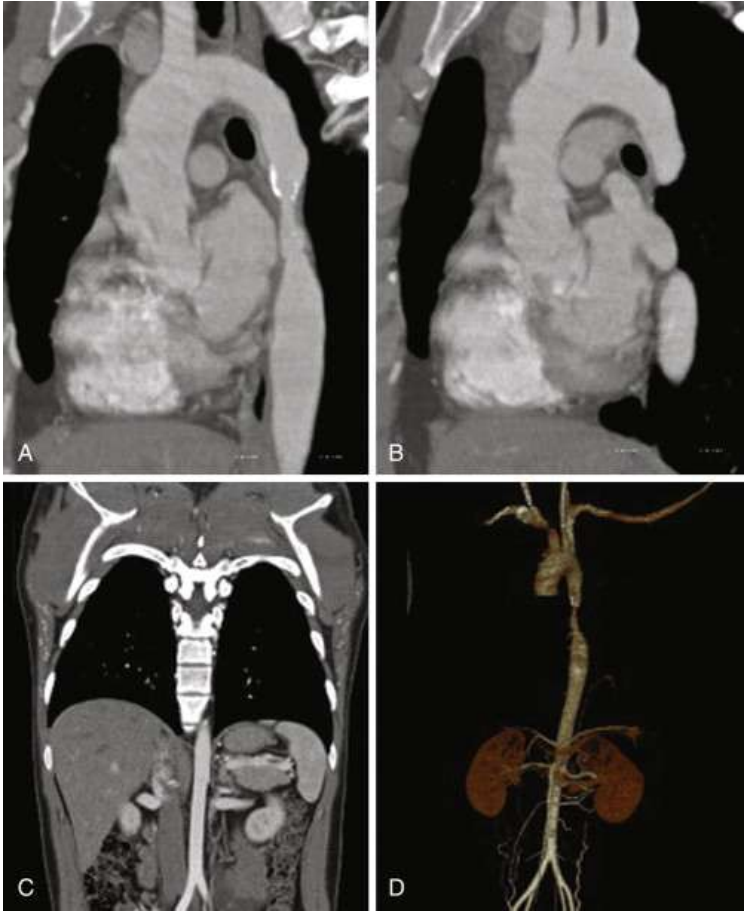


Figure 26-46

A 20-year-old man presented with hypertension resistant to antihypertensive medication. **A**, CT showed focal stenosis of the mid-portion of the descending aorta at the T4 to T5 level. **B**, The aortic arch, its branches, and the aortic isthmus showed well-developed contours without stenosis. **C** and **D**, The abdominal aorta and its major branches and aortic bifurcation also were morphologically normal. The patient was a healthy young man except for incidentally found upper body hypertension. There was no history of any inflammatory signs or symptoms suggesting a diagnosis of Takayasu arteritis. Routine laboratory work, including C-reactive protein and erythrocyte sedimentation rate, was normal. No other systemic changes, such as neurofibromatosis or chromosomal anomalies, were detected. The etiology in this patient's case is believed to be congenital, because no evidence of inflammatory arteritis or systemic disease was found and no other segment of the aorta or its branches was involved.

(Reprinted with permission from Park HK, Cho SH, Park YH. Atypical coarctation of the aorta: congenital stenosis of the mid-thoracic aorta. *J Am Coll Cardiol*. 2009;53(22):2098.)

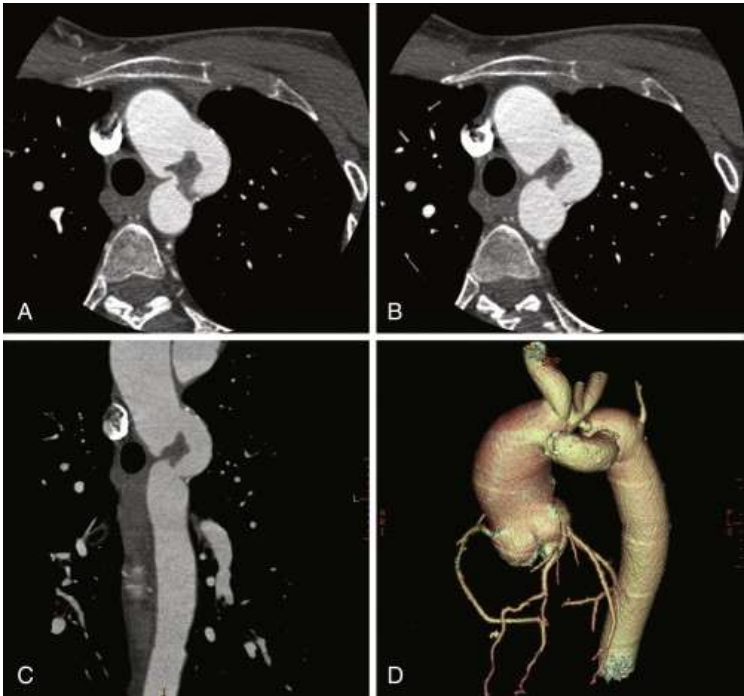


Figure 26-47
A 35-year-old man with a history of severe arch hypoplasia/coarctation. There is a marked narrowing of the midportion of the aortic arch. There has been a surgical Dacron graft bypass from the proximal portion of the aortic arch to the distal arch. The surgical bypass is intact, with no evidence of a stenosis, aneurysm, or pseudoaneurysm. A small amount of calcification within the graft is noted. The arch vessels are patent and extend from the proximal portion of the aortic arch. The ascending aorta is mildly dilated and measures 4.3 cm.

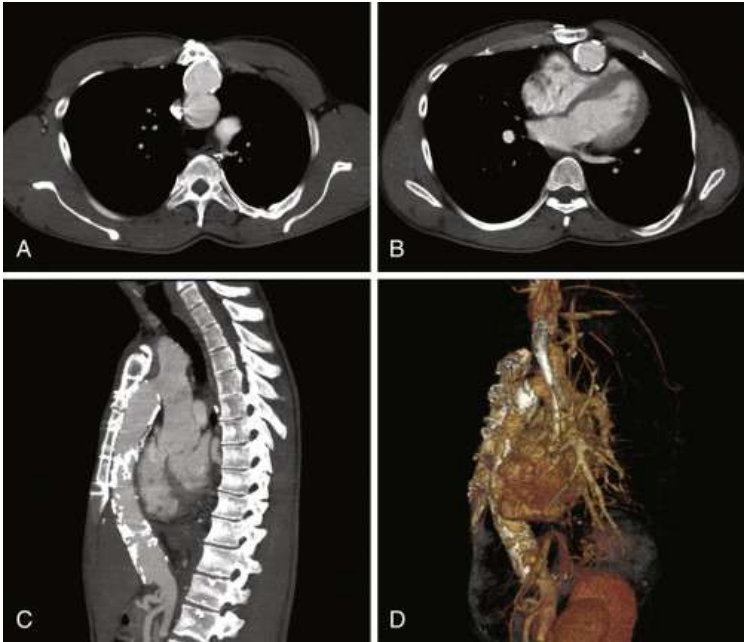


Figure 26-48
Multiple images from a gated CT angiogram of the chest and abdomen in a patient with a history of severe coarctation of the thoracic aorta with multiple failed surgeries. No evidence of a descending thoracic aorta is seen. This likely represents atresia of the descending thoracic aorta. **A** and **B**, There is a large conduit extending from the anterior aspect of the ascending aorta, which courses within the anterior mediastinum. **A** demonstrates the conduit compressing the midportion of the right ventricle. The conduit is heavily calcified, but not stenotic. **C** and **D**, Heavy calcification within the conduit, and normal distal anastomosis to the upper abdominal aorta, above the level of the celiac axis. See [Video 26-2](#).

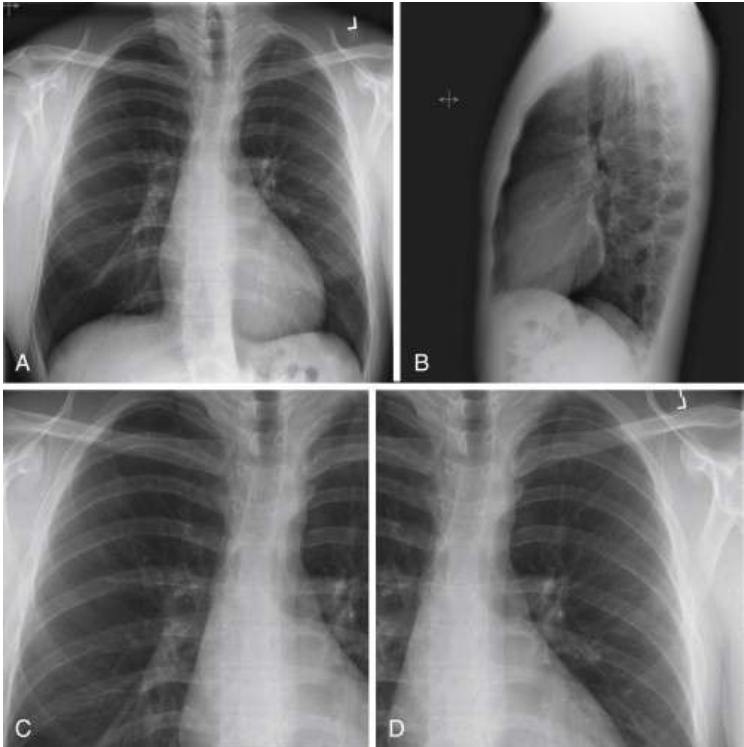


Figure 26-49

A 27-year-old man with a history of hypertension and paroxysmal atrial fibrillation. The posteroanterior (**A**) and lateral (**B**) chest radiographs demonstrate mild prominence of the left ventricular shadow as well as fullness in the anterior mediastinum on the lateral study. There is subtle prominence of the aortic arch, but a convincing “three sign” involving the aortic arch and proximal descending aorta is not appreciated. **C** and **D**, The presence of moderate bilateral rib notching is more obvious, especially on the magnified views.

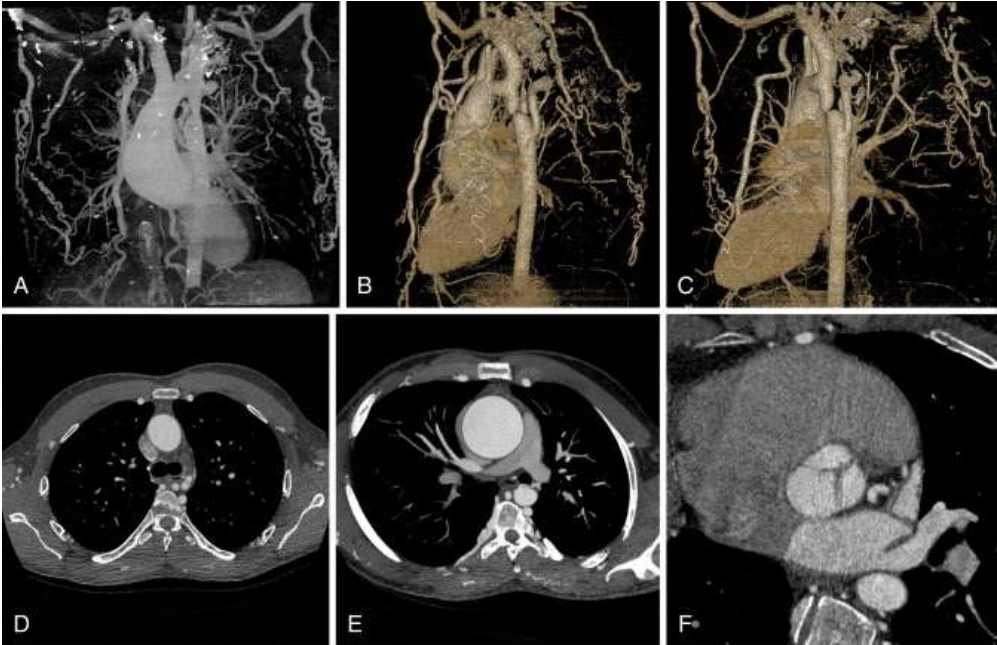


Figure 26-50

A 27-year-old man with hypertension and paroxysmal atrial fibrillation underwent ECG-gated CT angiography of the chest. The maximum intensity projection image (**A**) and the volume-rendered image (**B**) demonstrate marked collateral flow within the chest bilaterally, including massively hypertrophied internal mammary arteries as well as chest wall and intercostal arteries. **C** and **D** , Discrete focal coarctation in the proximal descending aorta with a bandlike cut-off. A short-segment aortic interruption likely is present. **E** and **F**, A large (6.2 cm) ascending aortic aneurysm is present. Aortic valve morphology is difficult to determine on prospective gated studies but suggests a “functionally bicuspid” aortic valve, confirmed on echocardiography. The aortic aneurysm therefore relates to bicuspid aortopathy.

Anomalies of the Aorta

CT is a superb test for imaging virtually any and all anomalies of the aorta and its branch vessels (**Figs. 26-51 through 26-54**), including :

- ☐ Right-sided aortic arch
- ☐ Aberrant right subclavian artery (arteria lusoria)
- ☐ Aberrant left subclavian artery
- ☐ Coarctation of the aorta
- ☐ Interruption of the aorta
- ☐ Diverticulum of Kommerell
- ☐ Patent ductus arteriosus
- ☐ Multiple patent ducti
- ☐ Bronchopulmonary sequestration
- ☐ Hypoplasia of the abdominal aorta

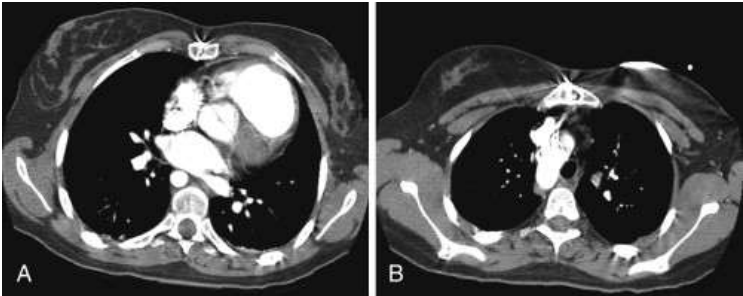


Figure 26-51

CT angiogram of the thorax in a 28-year-old woman with repaired tetralogy of Fallot. **A**, There is a moderately enlarged right ventricular outflow tract. Incidental note is made of a bicuspid aortic valve. The aortic arch is right-sided. Right-sided aortic arches are a common finding in patients with tetralogy of Fallot.

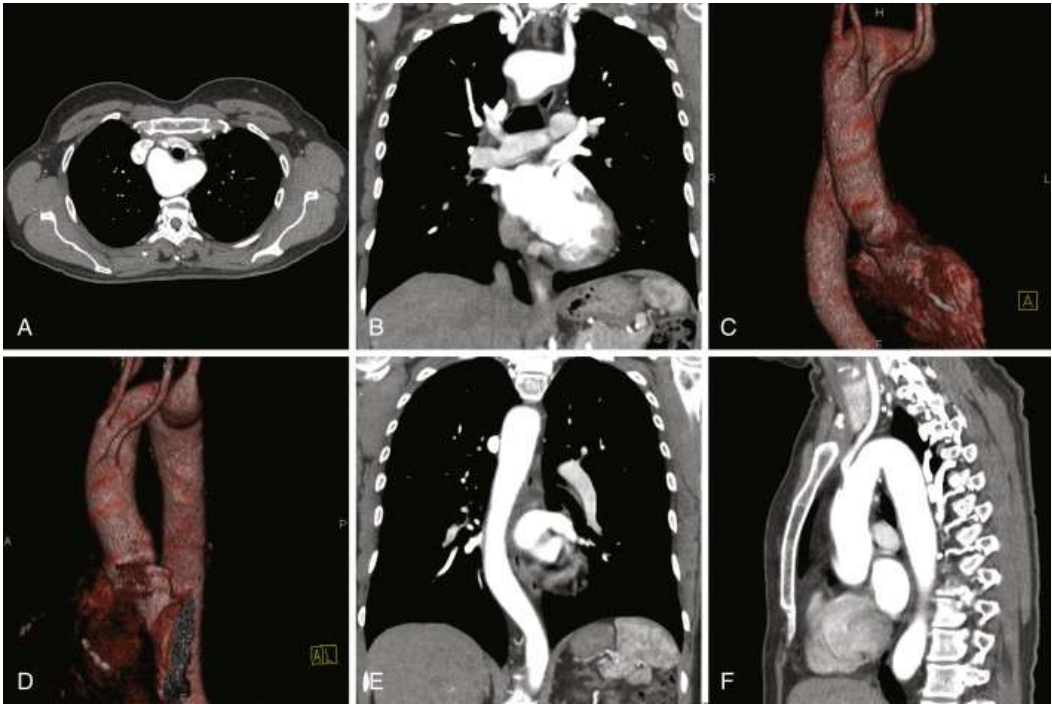


Figure 26-52
Right-sided aortic arch with arch branch vessel anomalies. A diverticulum of Kommerell is present at the origin of the left subclavian artery. The left common carotid artery arises as the first branch vessel. The arch also peaks unusually abruptly and high in the chest.



Figure 26-53
Hypoplasia of the abdominal aorta associated with hypomelanosis of Ito. **A**, Contrast-enhanced multidetector CT imaging of the thorax and abdomen on a coronal plane shows an interruption of the abdominal aorta (*) immediately distal to the origin of the renal arteries. **B**, Three-dimensional reconstruction shows hypoplasia of the abdominal aorta. Multiple small vessels arise to irrigate the lower extremities (white arrows), mimicking a pseudo cauda equina. The asterisk marks the ventriculoperitoneal shunt.
(Reprinted with permission from Vivas D, Garcia-Guereta L, Bret M, et al. Images in cardiovascular medicine. Hypoplasia of the abdominal aorta and hypomelanosis of Ito: "Pseudo-cauda equina" imaging. *Circulation*. 2009;120(20):2025-2026.)

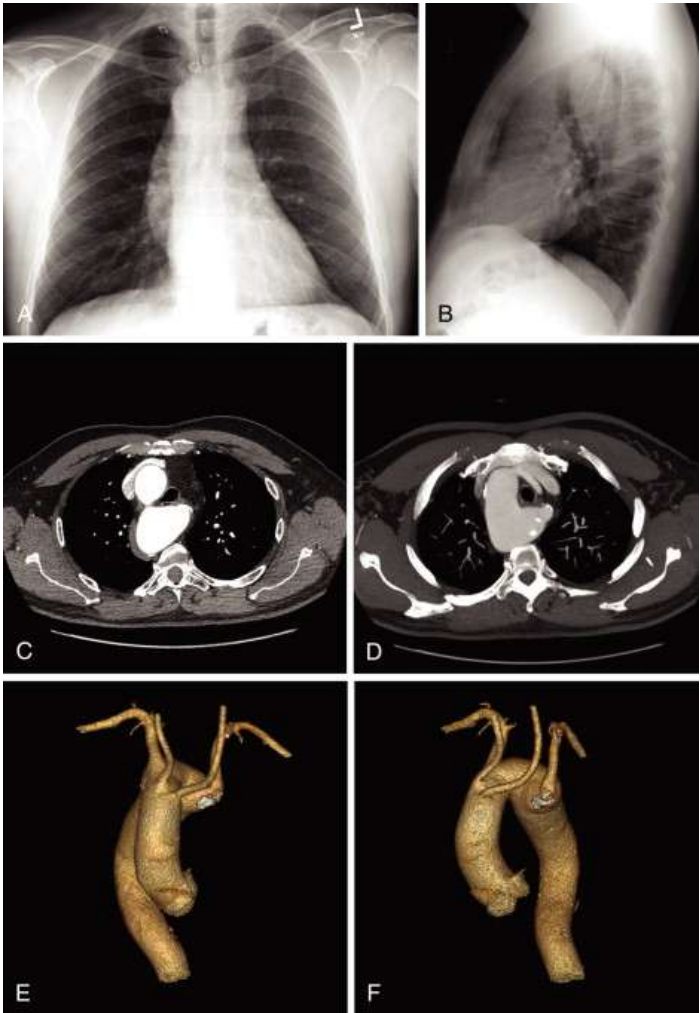


Figure 26-54
A 32-year-old male presenting with dysphagia. Posteroanterior (**A**) and lateral (**B**) chest radiographs demonstrate a right-sided aortic arch. The lateral study (**B**) demonstrates a large region of soft tissue posterior to the trachea. **C** and **D**, Axial images from gated CT angiography of the thorax demonstrate a right-sided aortic arch, and a large focal outpouching representing a diverticulum of coronal coursing posterior to the trachea. The esophagus is almost entirely effaced. **E** and **F**, The volume-rendered images demonstrate a large diverticulum of Kommerell from which an aberrant left subclavian artery arises. A moderate amount of calcific plaque is seen involving the diverticulum of Kommerell. Vascular compression of the esophagus resulting in dysphagia has been described as *dysphagia lusoria* .

Traumatic Disruption of the Aorta

Violent deceleration injury to the body may result in traumatic disruption of the aorta (**Figs. 26-55 through 26-61** and).

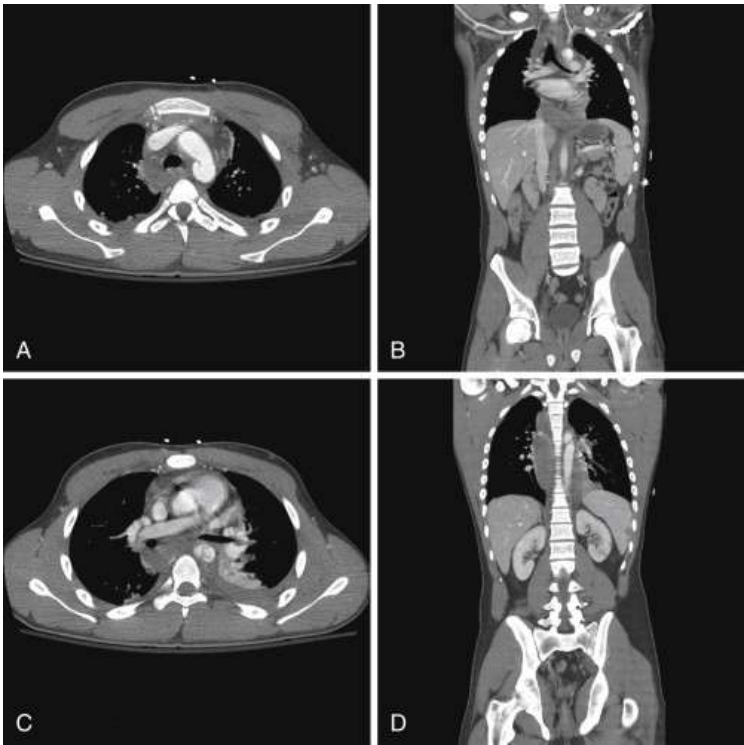


Figure 26-55
Contrast-enhanced chest and body images of a patient with a traumatic disruption of the proximal descending aorta following a motor vehicle collision. The site of disruption is short. The disruption includes a short flap and localized false lumen. There is mediastinal hematoma associated with the traumatic disruption of the aorta.

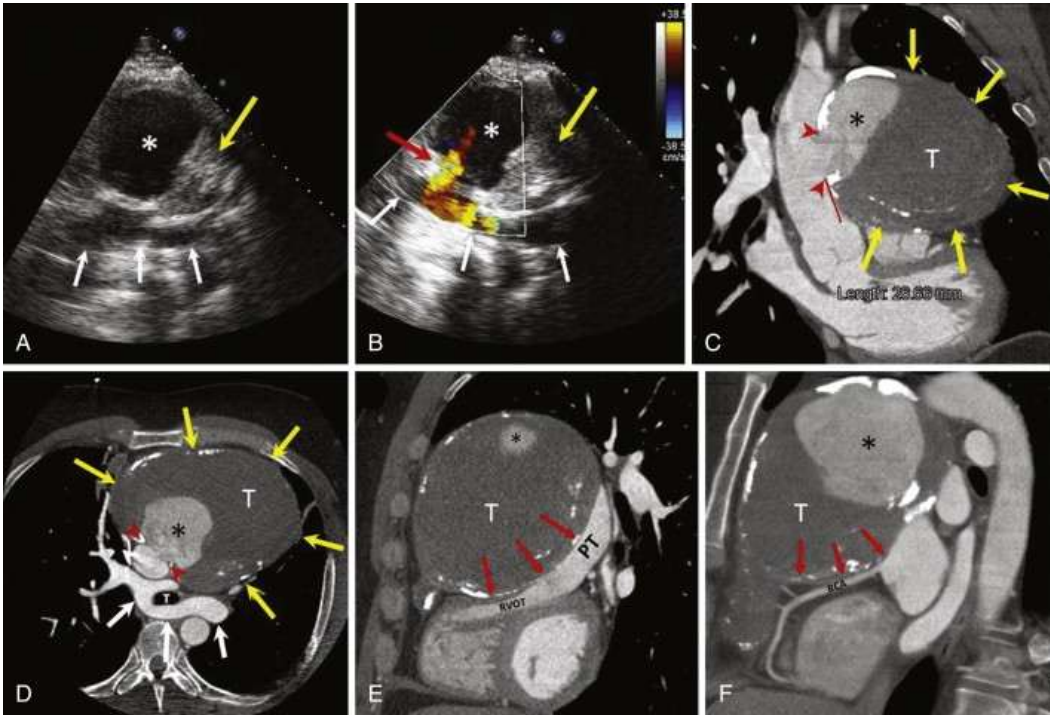


Figure 26-56
Same patient shown in [Figure 26-55](#) . Gray scale (**A**) and color Doppler (**B**) transthoracic echocardiograms (TTE) demonstrate a large, relatively anechoic lesion (*) within the mediastinum anterior to the ascending aorta (*small white arrows*). Color Doppler demonstrates communication of the anechoic lesion with the ascending aorta via a narrow neck (*red arrow*), consistent with a pseudoaneurysm. The thick peripheral rind of heterogeneously echogenic material represents eccentric thrombus (*yellow arrow*). **C** through **F** , Multiplanar reformats (MPRs) from cardiac CTA demonstrate the narrow neck (*red arrowheads* in **C** and **D**) of the pseudoaneurysm that arises 2.7 cm above the sinotubular junction. Note both the patent portion (*) and extensive peripheral thrombus (label *T* and *yellow arrows*). The pseudoaneurysm markedly compresses the right ventricular outflow tract, causes the course of the pulmonic trunk to deviate, and borders the ostium and proximal right coronary artery, as indicated by red arrows in **E** and **F** . The diagnosis was chronic posttraumatic false aneurysm. (Reprinted with permission from Gupta P, Carr JJ, Kon ND, Entrikin DW. Giant pseudoaneurysm of the ascending aorta—preoperative evaluation and surgical planning facilitated by cardiac computed tomographic angiography. SCCT Case of the Month, February 2012; available at <http://archive.constantcontact.com/fs027/1101901294184/archive/1109402007784.html> .)

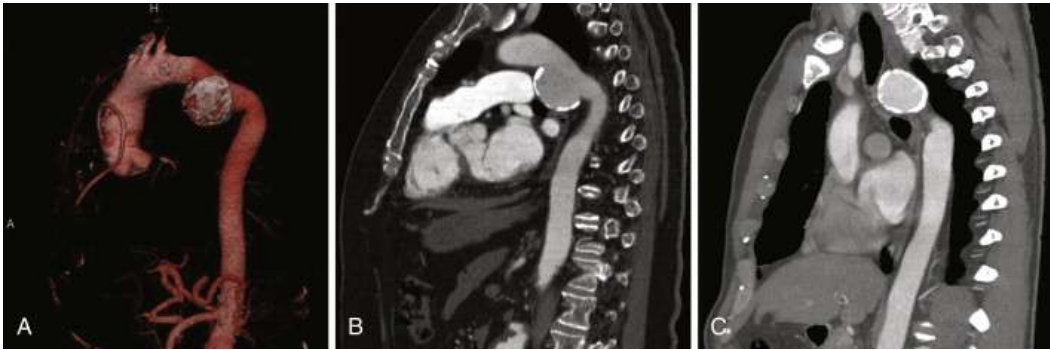


Figure 26-57
Circumferential calcification of the wall of a chronic traumatic false aneurysm.

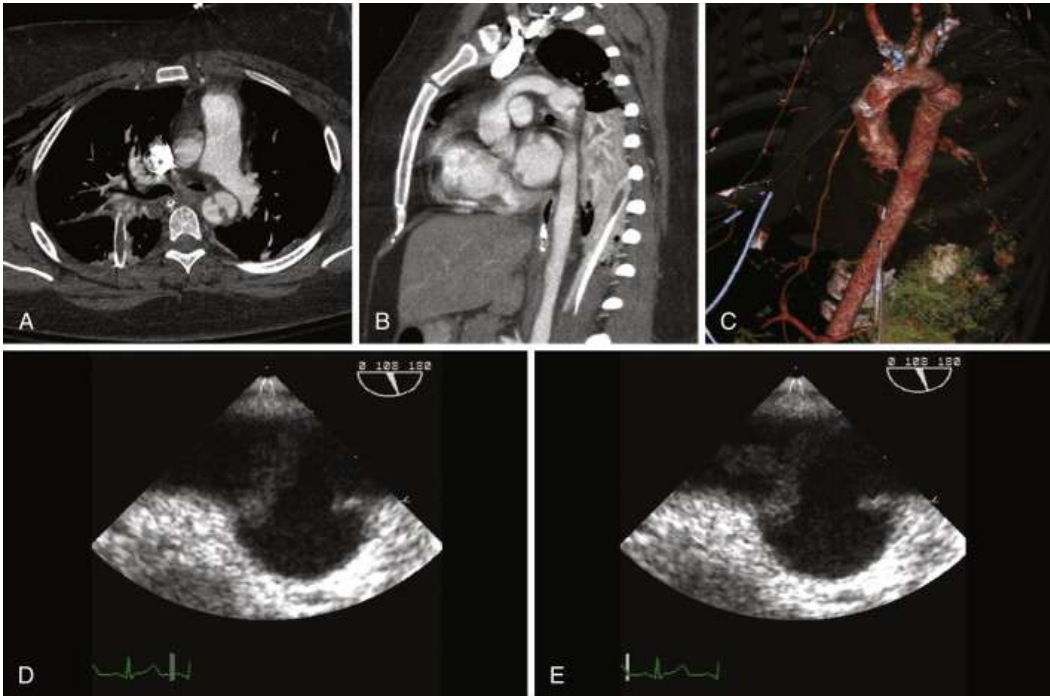


Figure 26-58
A 28-year-old woman injured in a high-speed motor vehicle accident. There is traumatic disruption of the proximal descending thoracic aorta. **A** , A linear discontinuity within the proximal descending thoracic aorta. No evidence of a mediastinal hematoma is seen on this single image. Incidental findings include extensive subcutaneous emphysema on the right and placement of a pleural drain on the right. A sagittal reconstruction (**B**) and a volume-rendered image (**C**) demonstrate a focal outpouching in the proximal descending thoracic aorta consistent with a traumatic aortic injury and development of a localized pseudoaneurysm. **D** and **E** , Transesophageal echocardiograms demonstrate focal outpouching at the level of pseudoaneurysm formation. Linear regions of intermediate echogenicity adjacent to this likely represent areas of intimal disruption, and localized clot formation. See



Figure 26-59
A 22-year-old female trauma patient injured in a high-velocity motor vehicle accident. **A**, Axial image demonstrates a moderate amount of mediastinal soft tissue/hemorrhage. There is an acute aortic injury, with a focal outpouching seen extending from the descending thoracic aorta anteriorly and inferiorly. This is best seen on the sagittal reconstruction “candy cane” view (**C**) and represents a focal aortic transection within the proximal descending thoracic aorta. The patient underwent stent grafting.

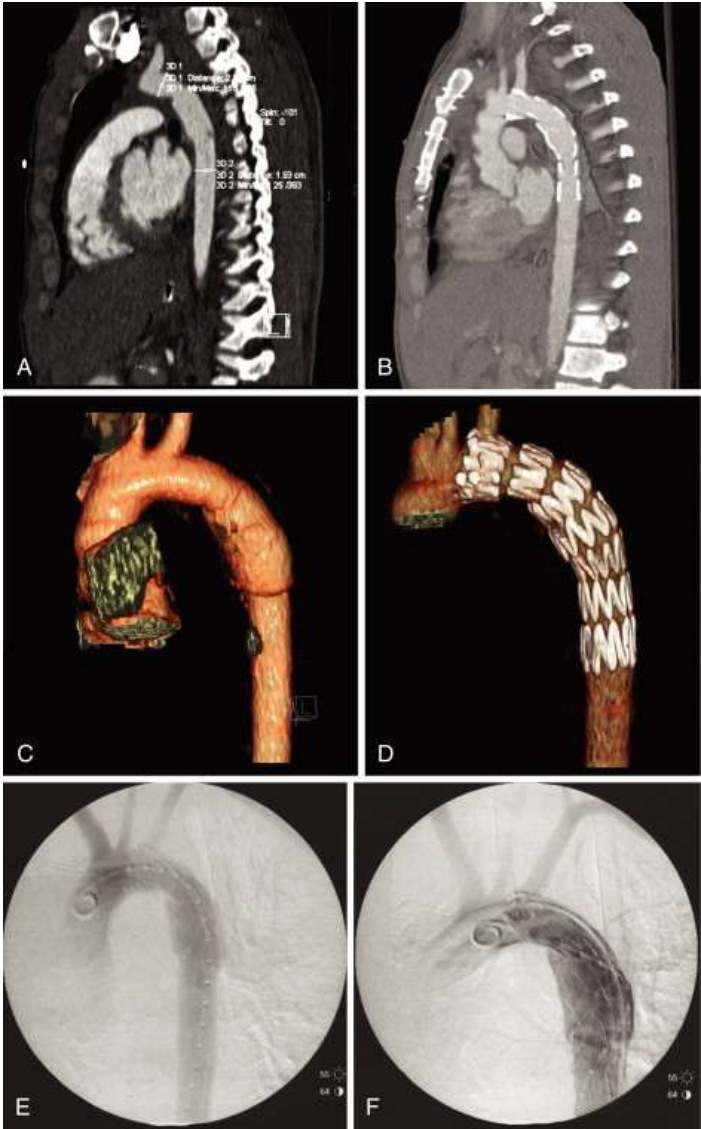


Figure 26-60
A 19-year-old man with an acute aortic injury post–motor vehicle accident. There is focal contour abnormality of the proximal descending thoracic aorta (**A**, **C**, and **E**). The trauma CT scan was used to plan placement of an aortic stent graft (**B**, **D**, and **F**).

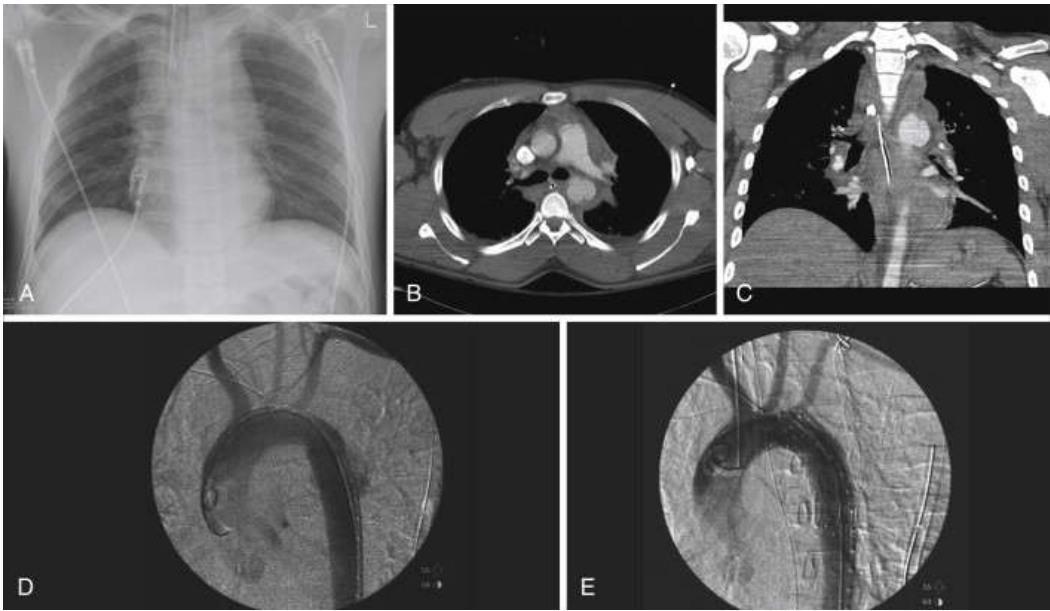


Figure 26-61
Traumatic disruption of the aorta.

Victims typically were not wearing seatbelts and were ejected from a vehicle moving faster than 50 km/hr. The most common sites of disruption are the isthmus (proximal descending aorta), the ascending aorta, and the supradiaphragmatic aorta.

Findings are not typically those of aortic dissection. Notably, the length of disrupted aorta is usually only a few centimeters, whereas in dissection half or more of the aorta usually is involved. Also, the principal finding is of a localized disruption/irregularity of the intima, not of a long, obvious, and freely mobile intimal flap.

As to be expected, older studies showed that CT was of limited value to exclude aortic disruption. However, more recent studies have demonstrated that for the evaluation of acute traumatic thoracic aortic injury, helical CT is equivalent to aortography in terms of sensitivity and negative predictive value, but CT is less expensive than aortography. The finding of mediastinal hemorrhage is sensitive for the diagnosis of traumatic aortic injury, but direct findings of aortic injury are more specific.

Noninfectious Aortitis

Several different inflammatory diseases, including Takayasu arteritis, giant cell arteritis, systemic lupus erythematosus, and others, may involve the aorta.

The cardinal feature of Takayasu arteritis is wall thickening due to inflammation and edema. CT is as well suited as MRI/MRA to image both the thickening of the wall and the resultant narrowing of the lumen of the aorta as well as of the (arch) branch vessels. Combined positron emission tomography (PET)-CT may offer a means to show the increased metabolism of the aortic wall affected by aortitis.

Later-stage Takayasu arteritis may evolve to aneurysms, dissections, fistulas, and even porcelain (diffusely calcified) aorta.

For images of Takayasu arteritis, see [Figures 26-62 through 26-73](#) .

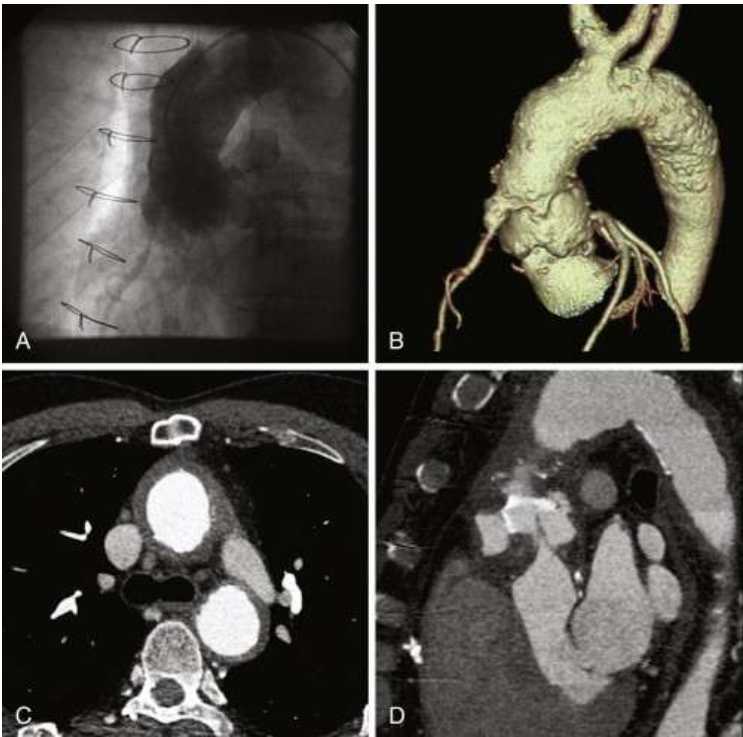


Figure 26-62

A 26-year-old man with a known history of Takayasu arteritis and prior placement of an ascending aortic graft. The patient presented with acute chest pain. **A**, Aortic root injection prior to coronary angiography. The ascending aorta is enlarged and irregular in appearance. **B**, An ECG-gated CT scan of the thorax, volume-rendered image demonstrates all irregular and diseased thoracic aorta views. Deformity of the proximal descending aorta reflects the patient's prior graft site. **C** and **D**, Extensive soft tissue thickening around the ascending and descending aorta in keeping with the patient's diagnosis of Takayasu arteritis. Multifocal areas of calcification also are seen within the thoracic aorta, likely secondary to chronic inflammation as opposed to atherosclerotic disease in this man. Small-volume lymph nodes within the mediastinum also are noted, likely reactive to the underlying inflammatory process.

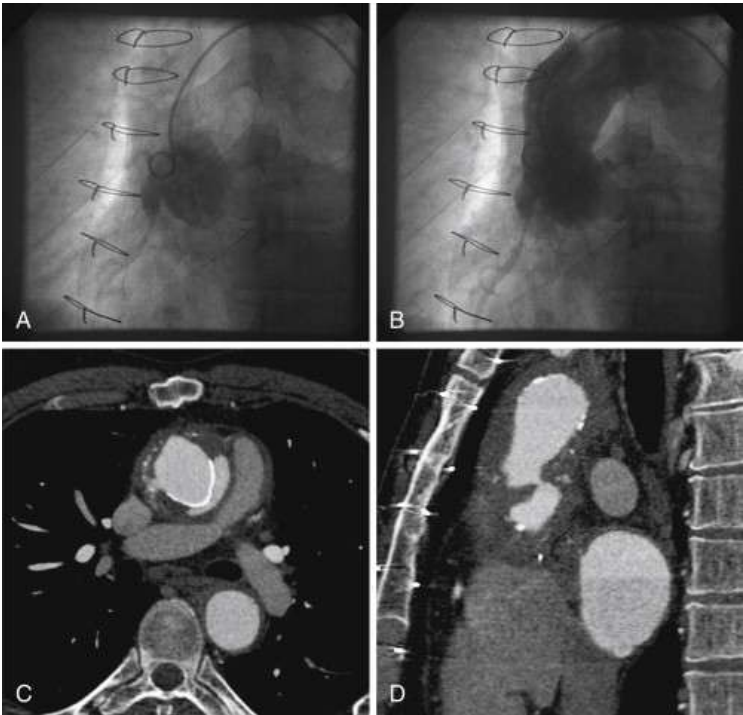


Figure 26-63

Same patient as [Figure 26-62](#) . The patient presented with acute chest pain. **A**, Initial images from an aortic root injection demonstrate ectasia of the proximal right coronary artery (RCA). **B**, Subsequent images from the aortic root injection demonstrate faint contrast outside the confines of the aortic root, best seen projecting inferior to the RCA origin and posterior to the aortic root. **C**, Peripheral high-density material seen within the aortic root demonstrates a portion of the descending aortic graft. This shows deformity and likely some compression from a collection of contrast medium, and also narrows the main and right pulmonary artery posterior to the valve aneurysm. There is suspicion of a discontinuity of the aortic graft along the right aspect of the graft. **D**, Sagittal oblique reconstruction also demonstrates communication between the aortic root and a perigraft/periaortic collection. The diagnosis was postoperative false aneurysm around the ascending aorta, potentially from breakdown of the graft anastomosis in a patient with Takayasu arteritis.

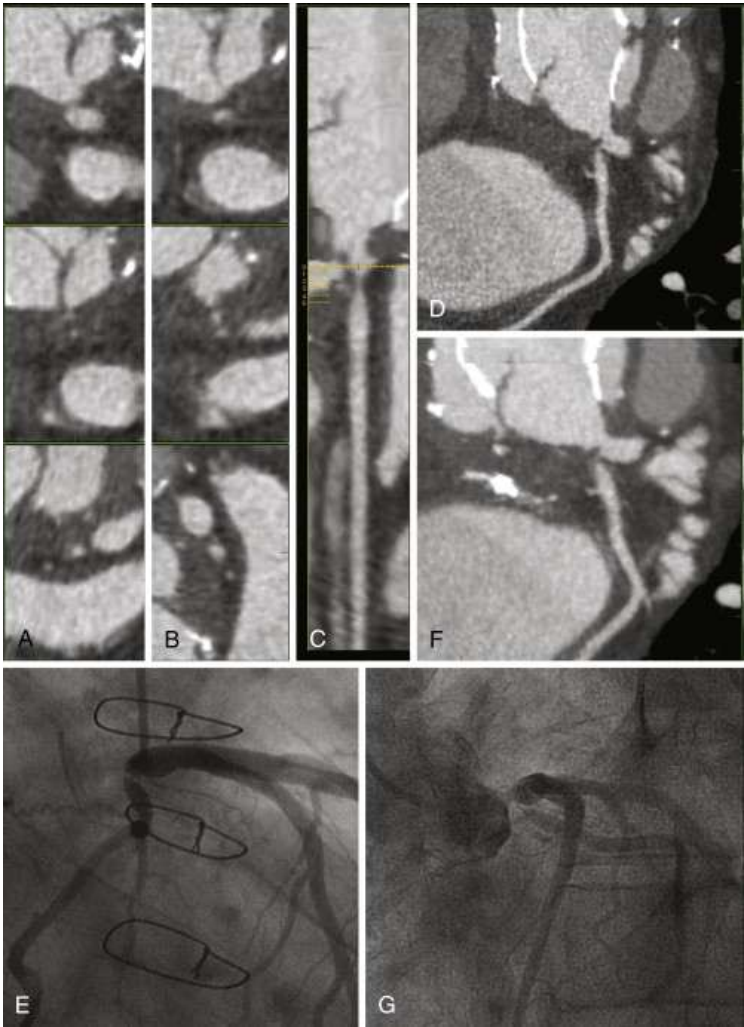


Figure 26-64
Same patient as [Figure 26-62](#) . The patient presented with acute chest pain. Multiple reconstructed images from a cardiac CT study demonstrate a severe stenosis of the proximal circumflex artery. The circumflex artery arises very proximally from a very short left main. Corresponding conventional angiography was performed. At initial evaluation of the left coronary artery (**F**) it was unclear whether the left anterior descending and circumflex arteries have separate ostia from the aortic root. **G**, A right anterior oblique projection with the catheter tip within the aortic root demonstrates the left main to be a short vessel, with a moderate left main stenosis, and suggests that the circumflex artery in fact does arise from the left main, with a severe, 90% stenosis, confirming the findings seen on the patient's cardiac CT examination.

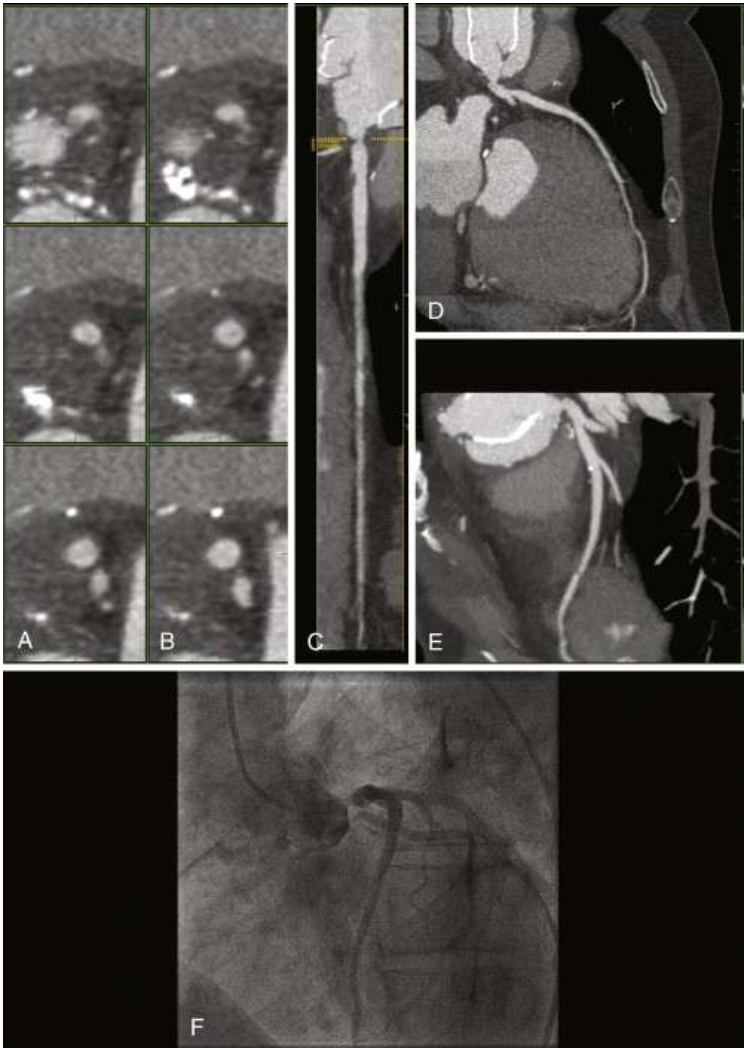


Figure 26-65
Same patient as [Figure 26-62](#) . **A** through **E**, Multiple cardiac CT images demonstrate abnormal soft tissue thickening around the aortic root, and a 50% stenosis of the left main coronary artery. This extends into the ostium of the circumflex artery (see Fig. 26-XX). This is most likely due to inflammatory process around the aortic root extending to the left main coronary artery. **F**, Conventional angiography confirms a 50% left main stenosis.

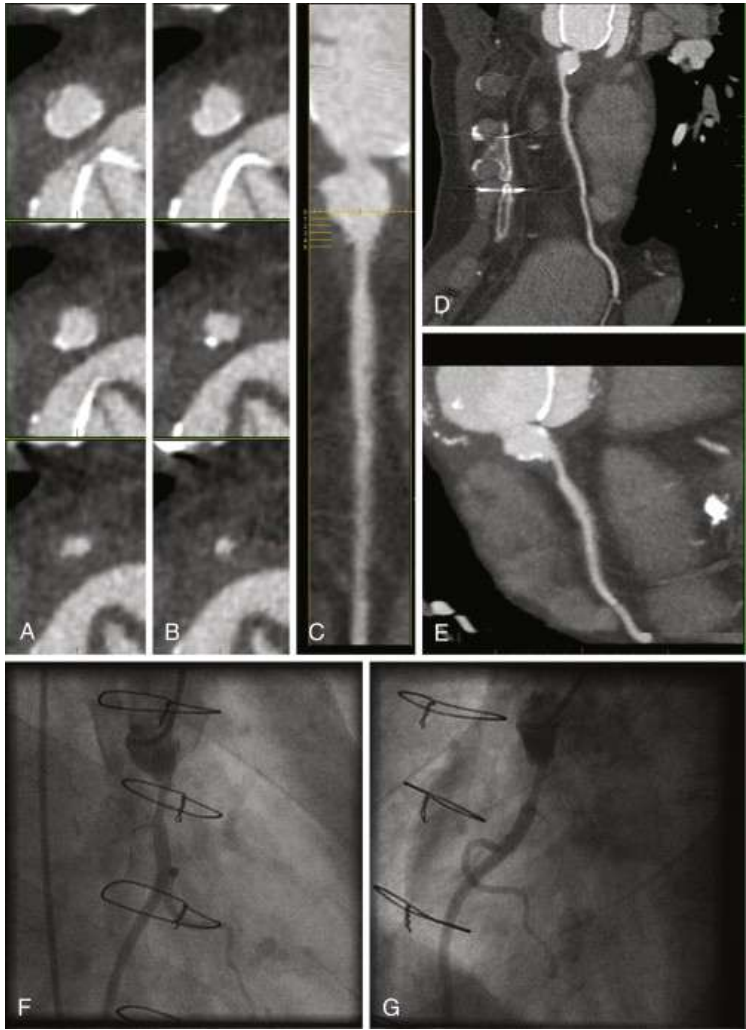


Figure 26-66
Same patient as [Figure 26-62](#) . Multiple cardiac CT images demonstrate a focal aneurysm of the proximal right coronary artery (RCA) measuring 14 mm. Cross-sectional views demonstrate moderate soft tissue extending from the ascending aorta, around the aneurysmal proximal RCA. There is a mild 30% to 40% stenosis of the RCA just distal to the aneurysm. Conventional angiography confirms the proximal RCA aneurysm, and mild narrowing of the ongoing proximal RCA.

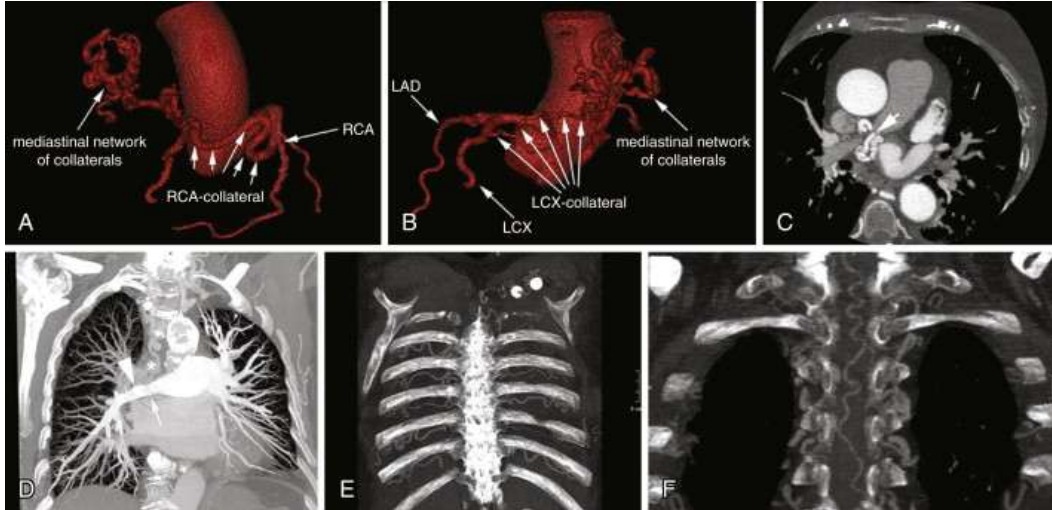


Figure 26-67
In a 78-year-old woman with chest pain and known Takayasu arteritis, prospective, electrocardiographically triggered, 320-slice cardiac CT revealed a network of arterial collateral arteries within the pericardium and mediastinum fed by the proximal right coronary artery (RCA) and proximal left circumflex coronary artery (LCX). **A** and **B**, Three-dimensional volume-rendered contrast-enhanced CT scans. **C**, Axial CT scan. Because of the patient's Takayasu arteritis, all three supra-aortic branches had progressively narrowed over decades and finally occluded. Furthermore, stenosis of the right pulmonary artery with lobar occlusion to the right upper lobe (**D**), capacious intercostal arteries with rib erosions (**E**), and a dilated spinal artery (**E**) could be identified. Other causes of chest pain, including pulmonary embolism, aortic dissection, and obstructive atherosclerotic coronary artery disease, were successfully ruled out. The patient's symptoms suggest a coronary steal phenomenon. Redistribution of blood from the coronary arteries to the depicted network leaves dependent cardiac parenchyma at increased risk for undernourishment and myocardial infarction. LAD, left anterior descending coronary artery.
(Reprinted with permission from de Bucoart M, Hein PA, Patrik Rogalla P. Coronary artery proliferation and steal phenomenon in Takayasu's disease with occlusion of supra-aortic branches demonstrated by 320-slice computed tomography. *J Am Coll Cardiol* . 2010;56(12):e23.)

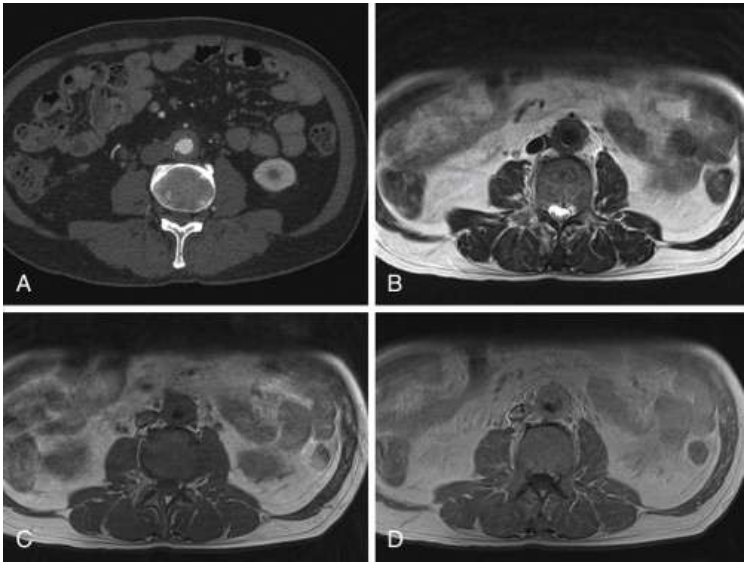


Figure 26-68
Composite images from a 28-year-old woman with Takayasu arteritis. **A**, CCT shows a moderate amount of soft tissue thickening circumferentially around the infrarenal abdominal aorta. The remainder of the images (**B – D**) are from an MRI study obtained one week later. **B**, T2-weighted image demonstrates the aortic wall thickening seen on the CT scan, but no increase in signal intensity associated with the aortic wall. The presence of aortic wall enhancement would suggest an acute inflammatory phase.

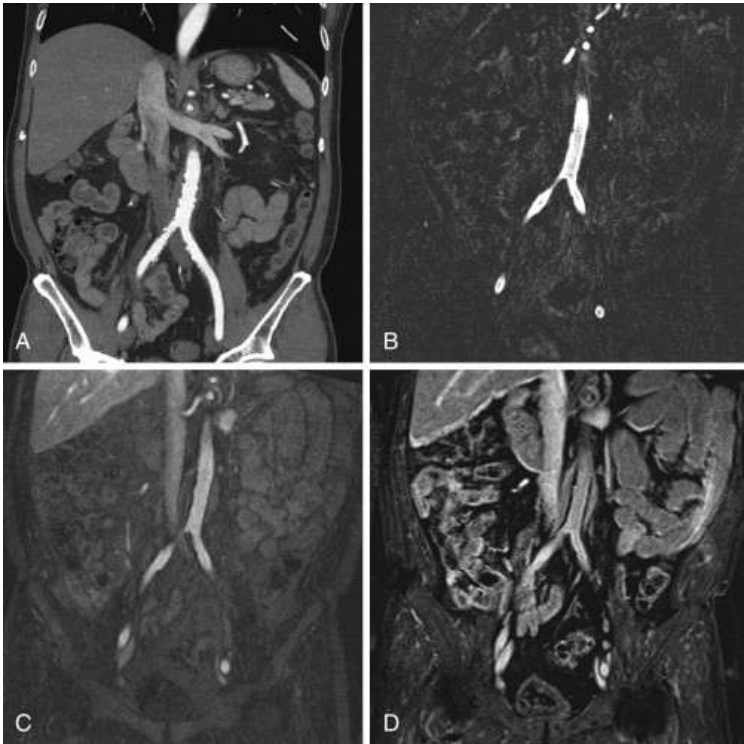


Figure 26-69
Composite images from a 28-year-old woman with Takayasu arteritis. **A**, Coronal image reformatted from an abdominal CT angiogram. There is a subtle thickening around the origins of the superior mesenteric artery and celiac axis. Also seen is soft tissue thickening around the infrarenal abdominal aorta just above the level of the bifurcation. The remaining images (**B – D**) are from an MR angiogram. **B**, MR angiogram obtained in the arterial phase immediately after administration of gadolinium. **C**, Image obtained 40 seconds later. **D**, Image obtained at 2 minutes after contrast administration. Delayed images demonstrate progressive enhancement of the soft tissue around the celiac axis and superior mesenteric artery, as well as around the infrarenal abdominal aorta. Demonstration of enhancement of the aortic wall in the setting of Takayasu arteritis is better appreciated on MR imaging than on CT imaging. This mural enhancement is suggestive of an inflammatory process.

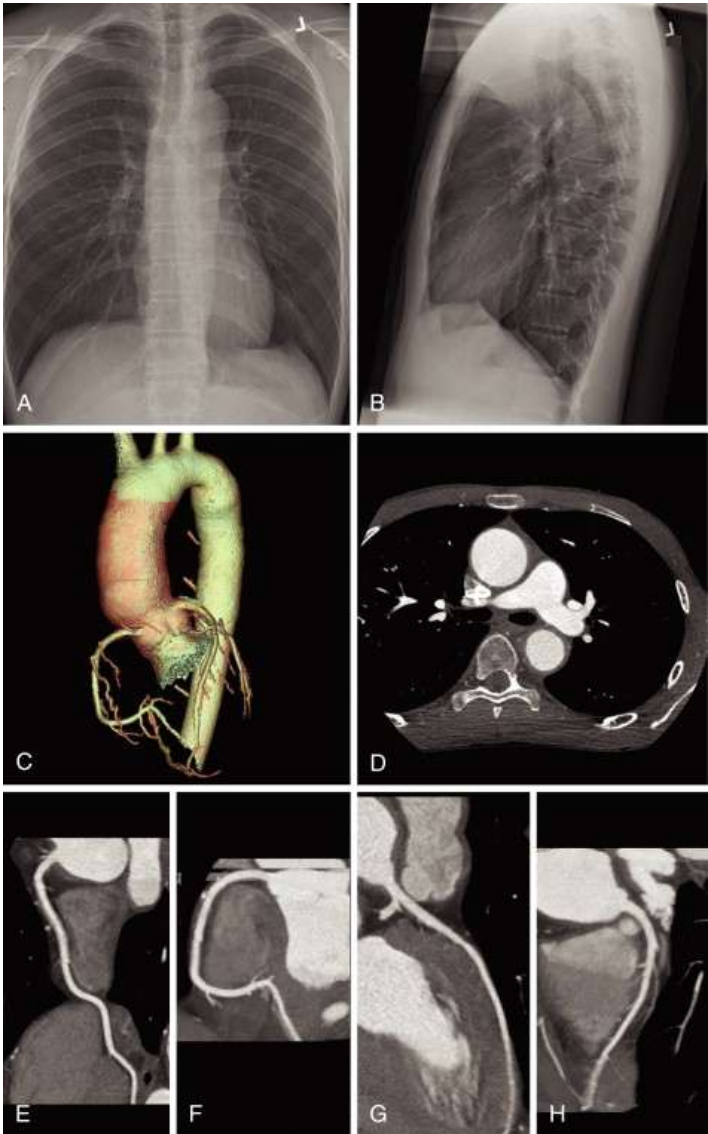


Figure 26-70
Multiple images from a 22-year-old man with Takayasu arteritis. Chest posteroanterior (A) and lateral (B) images demonstrate moderate enlargement of the aortic arch. The volume-rendered image (C) demonstrates moderate enlargement of the ascending aorta extending into the aortic arch, and focal dilatation of the proximal descending thoracic aorta. D, Mild to moderate soft tissue thickening around the ascending and descending aorta. E and F, A curved reformats and maximum intensity projection through the right coronary artery. No evidence of ostial disease or right coronary artery disease is seen. G and H, No evidence of disease extension into the left coronary artery ostium or left anterior descending artery is seen.

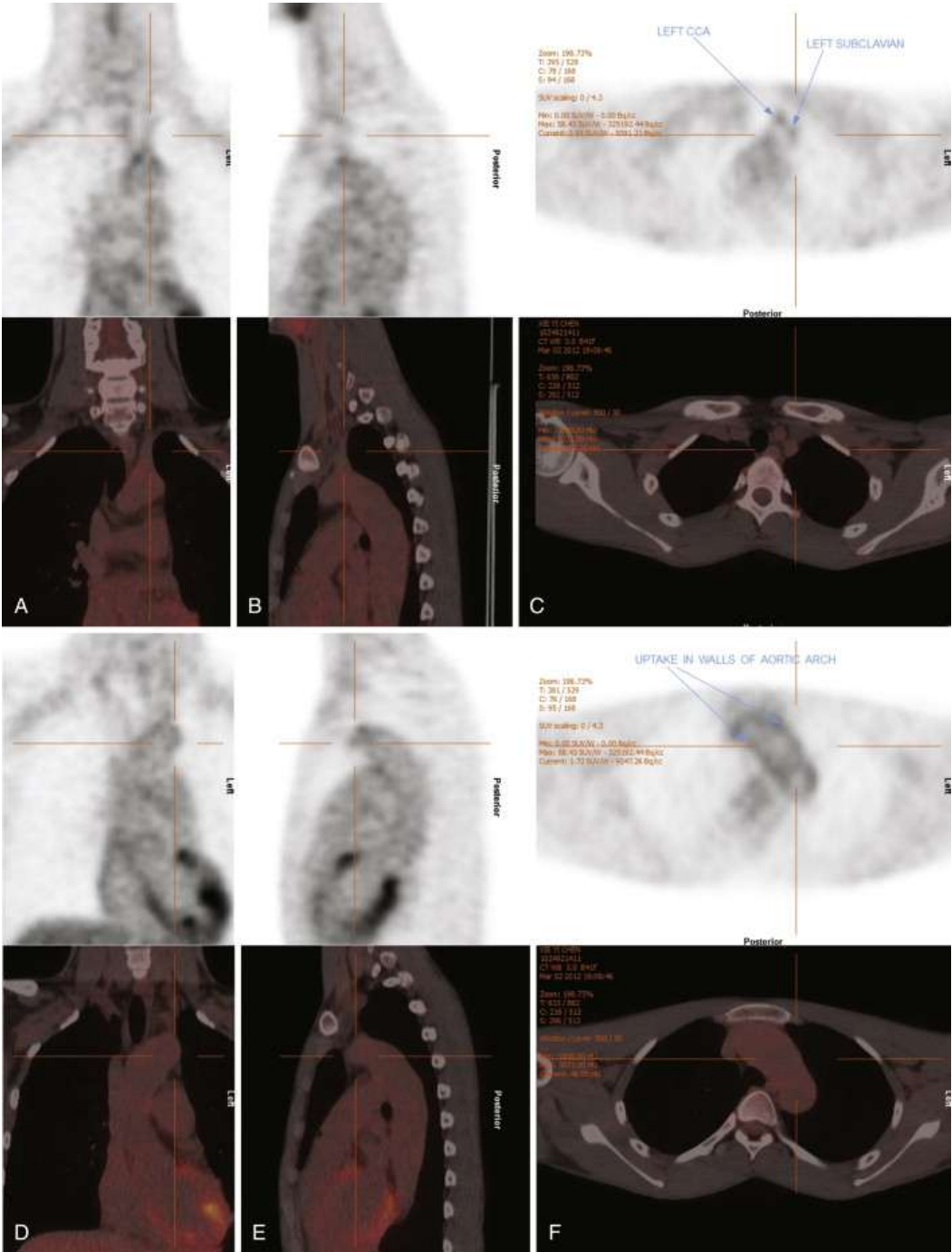


Figure 26-71 Multiple images from an 18F-fluorodeoxyglucose (FDG) CT–positron emission tomographic study on a 31-year-old man with Takayasu arteritis. **A** through **C**, A low-grade amount of increased metabolic activity within the left common carotid and left subclavian arteries. **D** through **F**, Low-grade activity within the aortic arch.

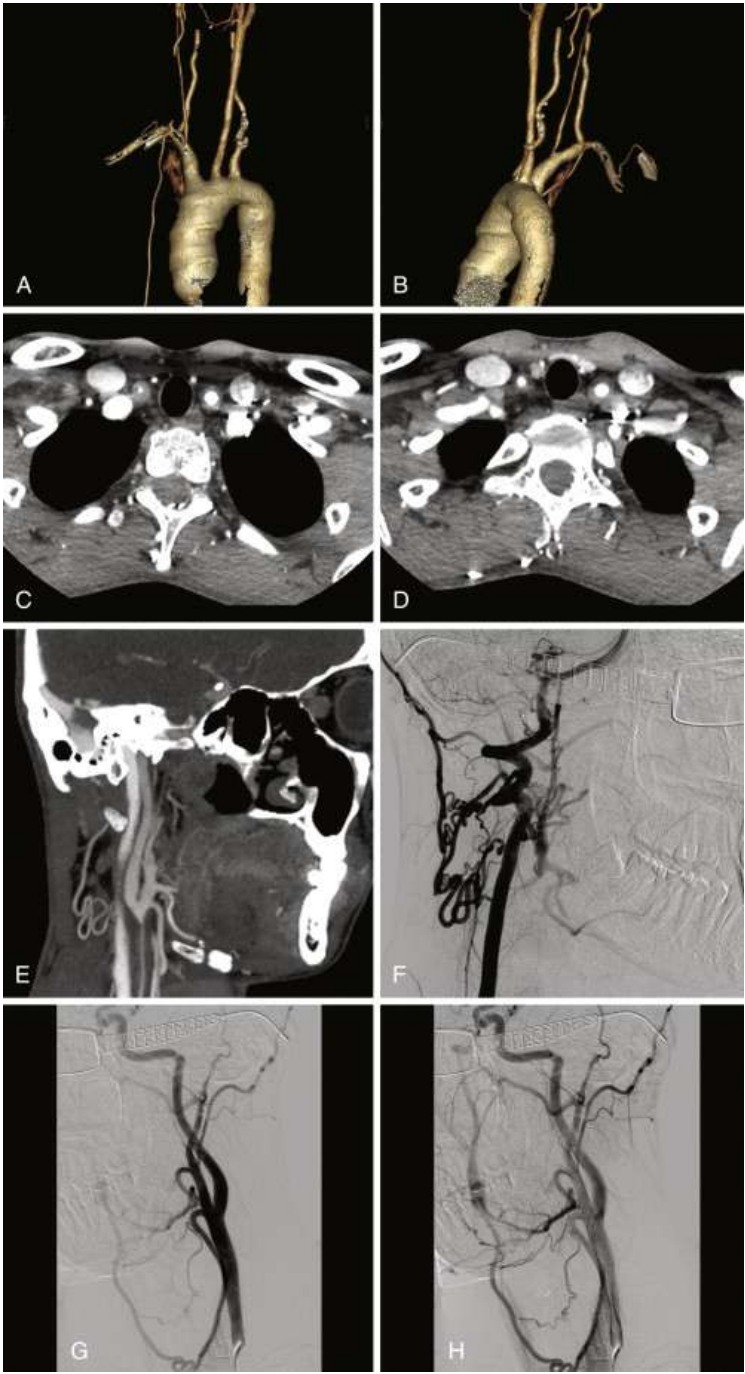


Figure 26-72
Multiple CT angiographic images of the neck in a 31-year-old man with Takayasu arteritis. **A** and **B**, The volume-rendered images demonstrate a long, string-like, attenuated right common carotid artery arising from the innominate artery. **C** and **D**, Axial source images demonstrate severe soft tissue thickening around the proximal right common carotid artery (**C**) and severe narrowing of the right common carotid artery lumen. Mild to moderate soft tissue thickening around the left common carotid artery is seen, but no significant associated stenosis is present. **E**, A sagittal maximum intensity projection image of the neck demonstrates a string-like attenuation of the right common carotid artery. The patient returned for conventional angiography 2 months later. The right common carotid artery had occluded in the interval and could not be cannulated. Cannulation of the right vertebral artery demonstrated multiple branches filling the occipital artery and external carotid branches. **G** and **H**, Injection of the left common carotid artery. A large left superior thyroid branch is seen extending across the midline to collateralize into the right superior thyroid gland and reconstitute the right internal carotid artery.

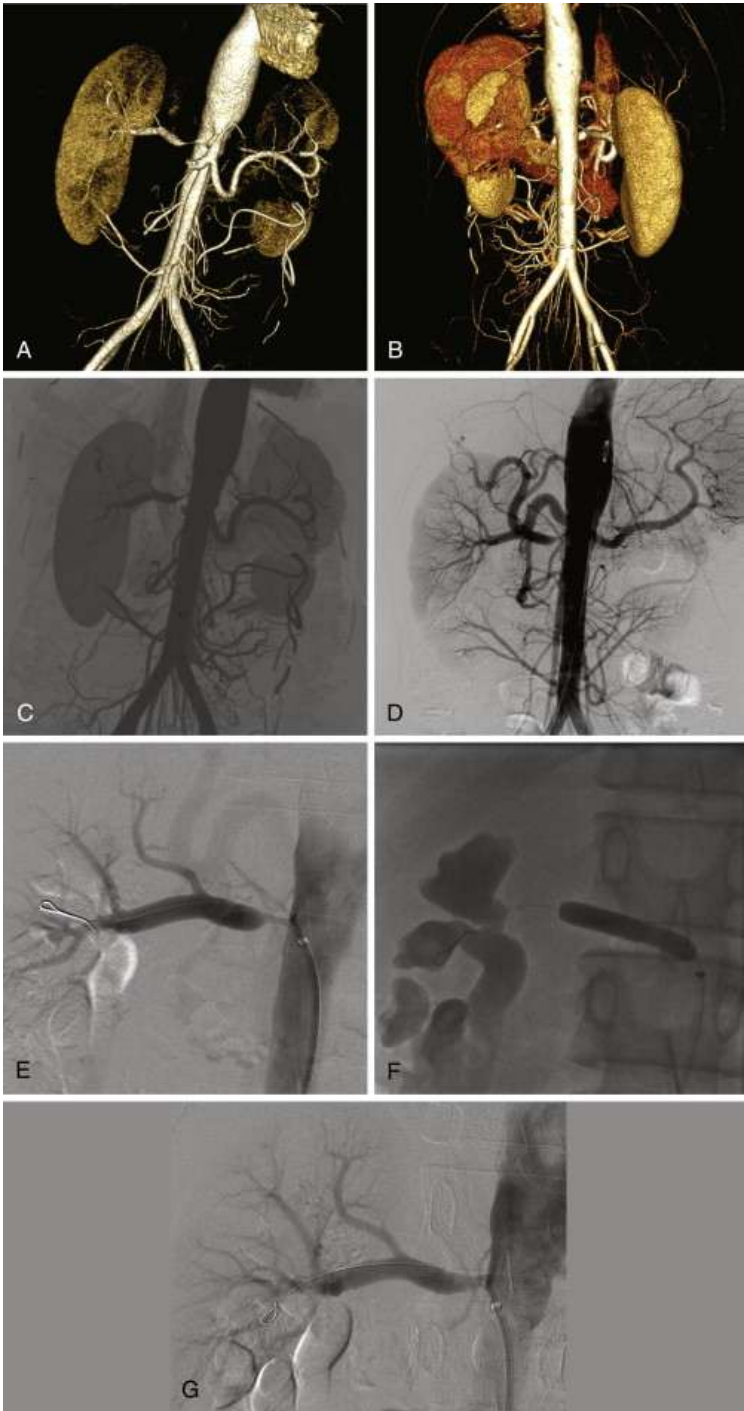


Figure 26-73
An 18-year-old woman with Takayasu arteritis and a history of hypertension. This figure describes changes involving the right renal system. **A** and **B**, Volume-rendered images from a CT angiogram demonstrate a normal right renal contour. There is ectasia of the suprarenal abdominal aorta and a severe stenosis within the proximal portion of a right renal artery that feeds the mid of the upper pole. A lower-pole accessory renal artery arises from the distal abdominal aorta. **C**, Maximum intensity projection image demonstrates the same findings. A conventional angiogram from an aortic flush on the left confirms the severe right main renal artery stenosis. Selective angiography of the right renal artery was performed with the guidewire placed beyond the stenosis (**E**). An angioplasty was subsequently performed, with a moderately successful result.

Hybrid PET-CT is able to localize increased 18 F-fluorodeoxyglucose (FDG) activity in the aorta and its proximal branches in cases of florid aortitis.

For images of PET imaging of the aorta, see [Figure 26-74](#) .

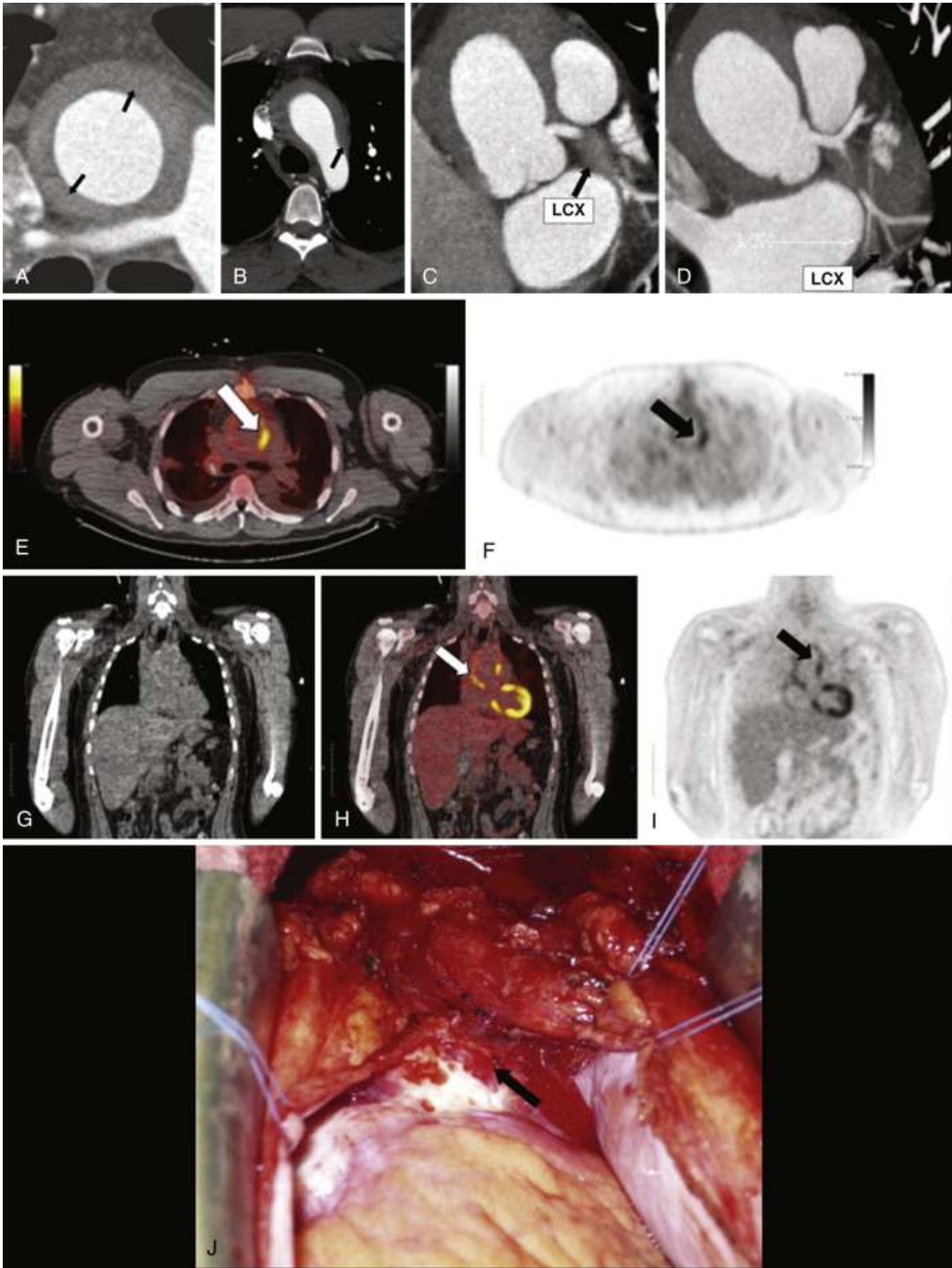


Figure 26-74

A and **B**, Multidirectional CT axial image of the aorta shows a smooth, contrast-filled lumen with intermediate density, extrinsic circumferential thickening of the proximal aortic wall (**A**, *black arrows*) that extends up to the aortic arch just distal to the left subclavian artery (**B**, *black arrow*). **C**, Axial CT image shows a hazy, soft tissue density over the proximal left circumflex (LCX) coronary artery with a compromised vessel lumen (*arrow*). **D**, Multiplanar reconstruction image shows proximal LCS coronary artery density with compromised contrast-filled lumen and a distal vessel that is widely patent with no atherosclerotic disease (*arrow*). **E** through **I**, Positron emission tomographic (PET) image shows areas of circumferentially increased 18F-fluorodeoxyglucose (FDG) activity of the whole proximal aortic root (*white arrows*) on a whole-body overlap noncontrast CT image. PET images show increased FDG activity in the thickened aortic wall region (*black arrows*). **J**, Intraoperative image shows a fibrotic, hardened, and inflamed proximal aorta with punctate hemorrhage that extends to the pericardium (*arrow*).
(Reprinted with permission from Mahenthiran J, El Masry H, Teague SD, Shahriari AP. Inflammatory aortitis with coronary arterial involvement by multidetector cardiac computed tomography. *J Cardiovasc Comput Tomogr*. 2008;2(4):276-280.)

Endovascular Treatment of the Aorta

CT scanning is the standard imaging test to plan for endovascular therapy, and to assess for success, complications, and failures (e.g., endoleaks).

For images of endovascular treatment of the aorta, see [Figures 26-75 through 26-77](#) .

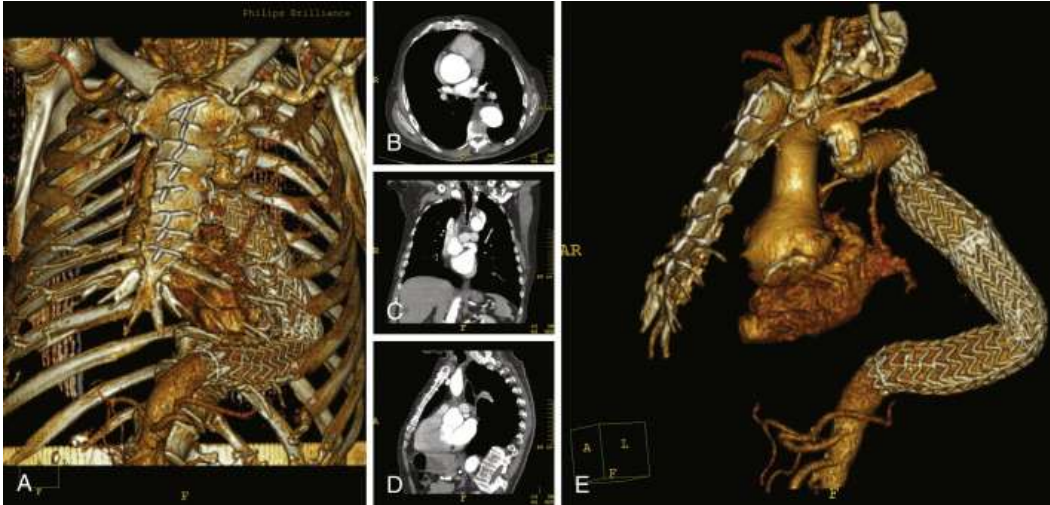


Figure 26-75

Volume-rendered images. **A**, Pre–chest cage removal function. **E**, After chest cage removal function.

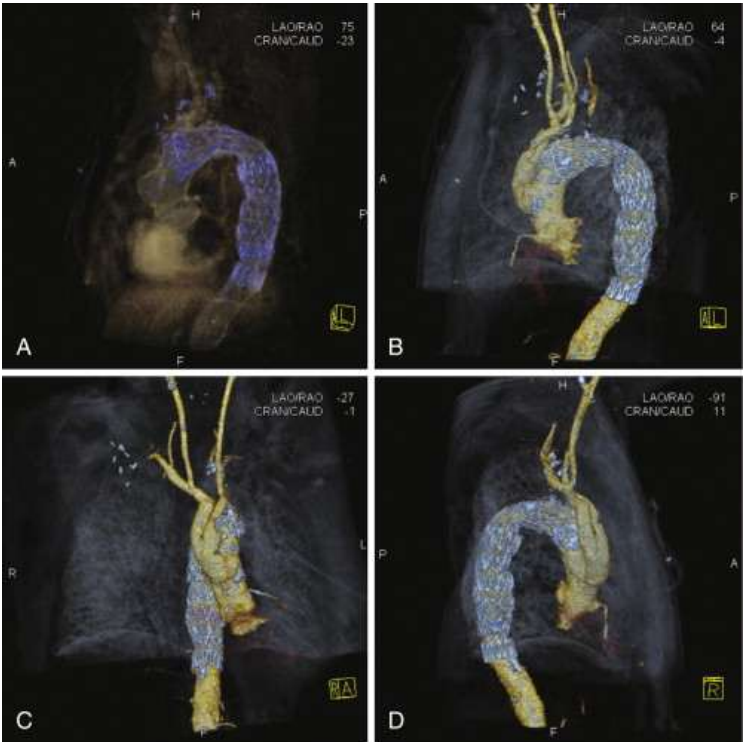


Figure 26-76
Three-dimensional volume-rendered views of the thoracic aorta following a “debranching” hybrid surgical-endovascular procedure where the arch vessels have been reimplanted onto a multiply branched graft segment anastomosed to the ascending aorta. The arch and descending aorta have been endovascularly repaired with two stent-grafts to seal off leaking penetrating ulcers. The arch vessels were moved out of the way of the stents to allow endovascular repair of the ulcer sites.

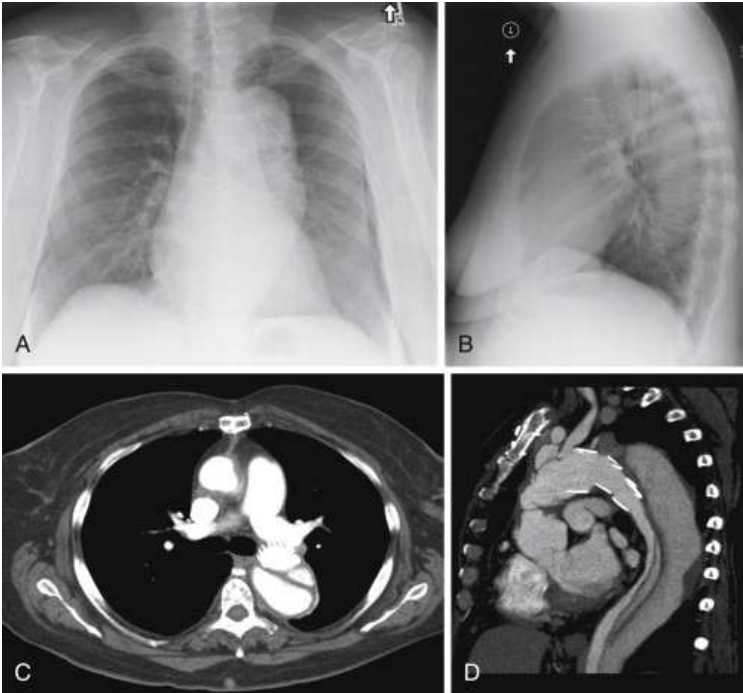


Figure 26-77
Chest radiograph and contrast-enhanced CT scan axial and sagittal views approximately matching the posteroanterior and lateral chest radiograph films. On the chest radiographs, the aortic stent is seen to be more fully deployed proximally than distally. Similarly, the posteroanterior (**A**) and lateral (**B**) chest radiographs show that the distal aspect of the stent is not deployed against the outer wall of the aorta. The CT scan images demonstrate a “triple-barreled” aorta due to recurrent dissection of the aorta. The true lumen within which the stent is deployed is clearly smaller than the false lumens, accounting for the appearance on the chest radiographs of incomplete expansion of the stents. The large false lumen posterior and lateral to the true lumen accounts for the appearance of the additional aortic tissue posterior and lateral to the stent, as seen in the chest radiographs.

Sinus of Valsalva Aneurysms

The sinuses of Valsalva represent the potential spaces between the valve cusps and the lateral wall of the aorta. A deficiency between the aortic media and annulus fibrosus of the aortic valve results in distention and eventual aneurysmal dilatation of the sinus, which often protrudes into adjacent structures. Eventually the aneurysms may rupture. Sinus of Valsalva aneurysms usually are isolated congenital lesions; however, they can be associated with ventricular septal defects and may be seen in other conditions such as Marfan syndrome and, less commonly, as a complication of endocarditis. Acquired sinus of Valsalva aneurysms are believed to rupture with less frequency than congenital aneurysms. Aneurysms most commonly arise from the right coronary sinus, followed by the noncoronary sinus and finally the left coronary sinus. Aneurysms of the right sinus often protrude into the right ventricular outflow tract or right atrium and can rupture into these right-sided structures, creating a left-to-right shunt. The patient develops sudden onset of chest pain with rapid development of heart failure due to the left-to-right shunt.

A possible differential diagnosis for a sinus of Valsalva aneurysm is a membranous interventricular septal aneurysm (IVSA). Membranous IVSAs develop in the course of spontaneous partial or complete VSD closure, by outpouching of either the septal leaflet of the tricuspid valve or thin membranes adjacent to VSD margins. Muscular IVSAs are extremely rare; they occur mainly in children or young adults, often in association with ASD or VSD (**Figs. 26-78 through 26-80** ;).

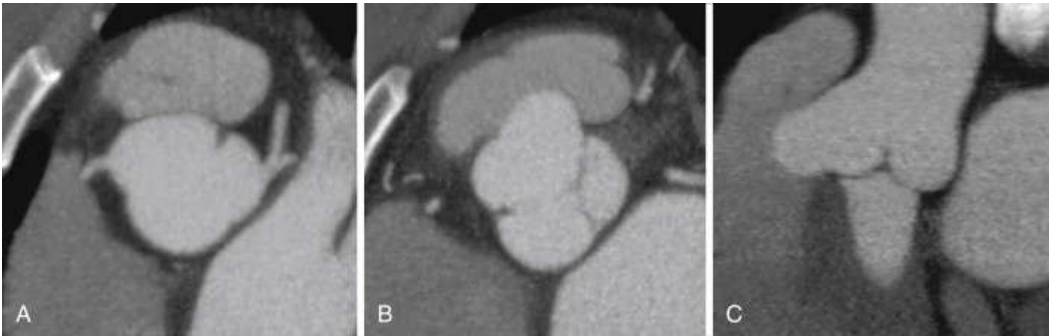


Figure 26-78

Multiple images from a cardiac CT study demonstrate a sinus of Valsalva aneurysm extending from the right coronary sinus of Valsalva. No evidence is seen of a shunt or rupture, and there is no evidence of internal thrombus or calcification.



Figure 26-79

A saccular aneurysm (67 × 48 mm) of the right sinus of Valsalva protruding into the right ventricular cavity. There was no associated aortic valve insufficiency.



Figure 26-80

Pre- (**A**) and post-contrast (**B**) images from a cardiac CT demonstrate peripheral calcification and thrombosis of a sinus of Valsalva aneurysm. There is no sign of residual shunting. **C** and **D**, Composite centered images from a cardiac CT study in another patient demonstrate a thrombosed and calcified sinus of Valsalva aneurysm extending from the right coronary sinus of Valsalva. This projects into the right ventricular outflow tract. No associated jet or ventricular septal defect is seen. See

The Postoperative Aorta

Complications following thoracic aortic aneurysm surgery are common. Postoperative findings that may simulate pathology or surgical complications include high-attenuation felt pledgets, native aortic wrapping around the graft, and graft kinks. Postoperative complications include perigraft hematomas, false aneurysms, and infected perigraft collections. Low-attenuation material around the graft in the acute postsurgical phase likely is secondary to the postsurgical inflammatory response. This condition tends to resolve over time. An increase in the amount of low attenuation around the graft, especially in association with increased stranding of the adjacent mediastinal fat, or the development of small foci of air within the low-attenuation material increases the suspicion for an infected perigraft collection. The presence of contrast material outside the confines of the graft raises suspicion for graft dehiscence and a perigraft pseudoaneurysm (**Figs. 26-81 and 26-82**).

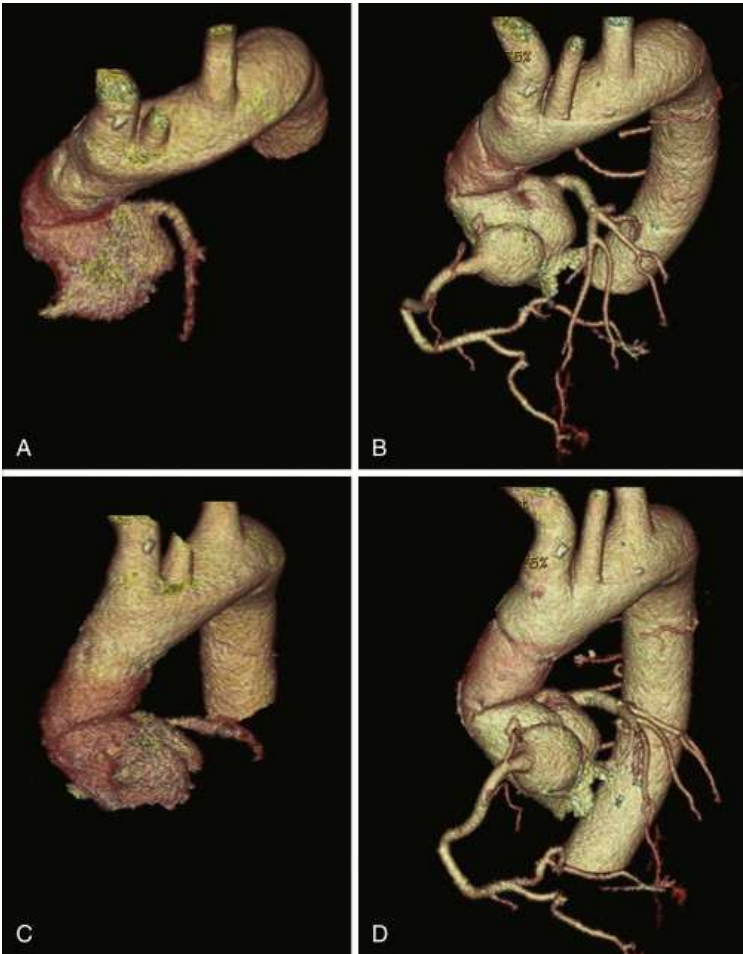


Figure 26-81
Two sets of images in a patient with prior resection of an ascending aortic aneurysm, and placement of a descending aortic tube graft. The purpose of this image set is to demonstrate image quality difference between a non-gated helical CT angiogram of the chest (**A** and **C**), and a prospectively acquired, ECG-gated CT angiogram (**B** and **D**). The ECG-gated images demonstrate much better detail of the aortic root and the coronary arteries. In this case the aortic root is negative, and will need ongoing surveillance. The proximal anastomosis above the level of the sinuses of Valsalva is kinked, but shows no evidence of any other postoperative complication. The dose of a helical non-gated study was 6.8 mSv, while the prospectively acquired gated study was done at a dose of 4.2 mSv.

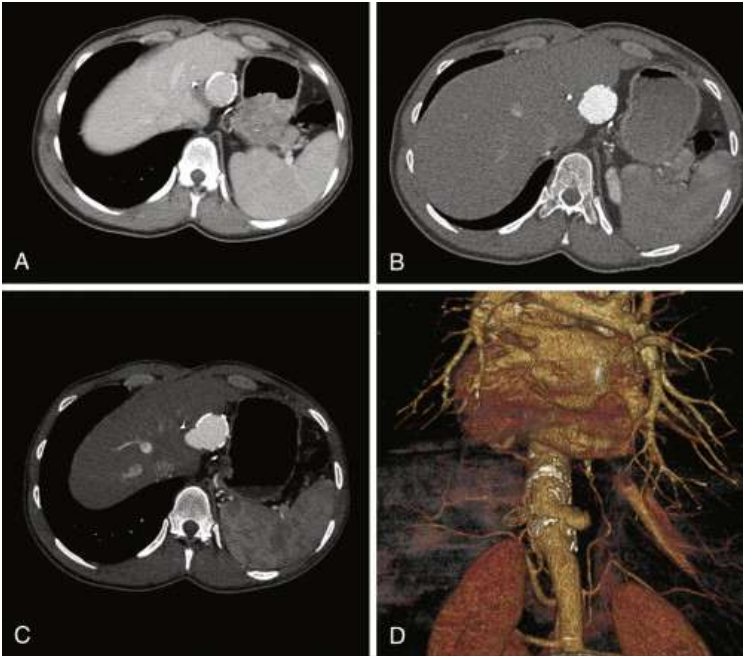


Figure 26-82
Multiple CT images in a 38-year-old man with a prior history of coarctation. He has had prior surgery to the thoracoabdominal aorta, which is more anteriorly placed than is normally seen. **A**, Obtained 1 month post-surgery when the patient presented with fever and abdominal pain. A small amount of low attenuation, possibly fluid, is seen adjacent to the right aspect of the abdominal aorta. **B**, The follow-up CT angiogram shows subtle irregularity and mild focal outpouching of the right aspect of the abdominal aorta. **C**, A further follow-up study 6 months later demonstrates a definite focal outpouching of the right side of the abdominal aorta. **D**, This is well demonstrated on the volume-rendered image (posterior projection). These images demonstrate the development of a mycotic aneurysm/pseudoaneurysm.

CCT Protocol Points

- □ Coverage: lung apices to diaphragm
- □ Contrast: 90 mL at 5 mL/sec
- □ Automated trigger set:
 - • location: descending aorta at the level of the left atrium

- •
- HU: 200

- Additional scans:

- •
- Precontrast images are needed to identify vascular calcification and acute IMH lesions
- •
- Delayed scan images (1–2 min) are needed to depict chronic false lumens and endoleaks post–thoracic endovascular aortic repair.

- See [Table 26-2](#) .

TABLE 26-2

ACCF 2006 Appropriateness for Use of CT Angiography for the Evaluation of Aortic Disease *

APPROPRIATENESS CRITERIA INDICATION		MEDIAN SCORE
Appropriate	Evaluation of suspected aortic dissection or thoracic aortic aneurysm	9
Uncertain	None	
Inappropriate	None	



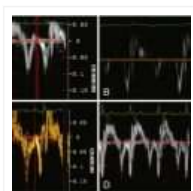
Data from Hendel RC, Manesh PR, Kramer CM, Poon M. ACCF/ACR/SCCT/SCMR/ASNC/NASCI/SCAI/SIR appropriateness criteria for cardiac computed tomography and cardiac magnetic resonance imaging. *J Am Coll Cardiol* . 2006;48(7):1475-1497.

* No listings for aortic diseases are included in the ACCF 2010 appropriateness guidelines.

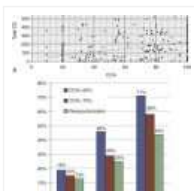
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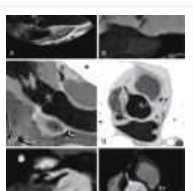
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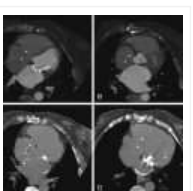
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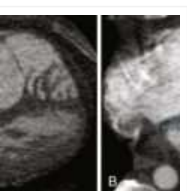
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