Thoracic aortic aneurysms (TAAs) can be broadly divided into true aneurysms and false aneurysms (pseudoaneurysms). True aneurysms contain all three layers of the aortic wall (intima, media, and adventitia), whereas false aneurysms have fewer than three layers and are contained by the adventitia or periadventitial tissues. Multidetector computed tomographic (CT) angiography allows the comprehensive evaluation of TAAs in terms of morphologic features and extent, presence of thrombus, relationship to adjacent structures and branches, and signs of impending or acute rupture, and is routinely used in this setting. Knowledge of the causes, significance, imaging appearances, and potential complications of both common and uncommon aortic aneurysms, as well as of the normal postoperative appearance of the thoracic aorta, is essential for prompt and accurate diagnosis. Supplemented material available at http://radiographics.rsna.org/cgi/content/full/29/2/537/DC1.
Introduction
An aneurysm is defined as an abnormal focal dilatation of a blood vessel. Multidetector computed tomographic (CT) angiography is routinely performed for the diagnosis and evaluation of thoracic aortic aneurysms (TAAs), having essentially replaced diagnostic angiography. Unlike conventional angiography, which demonstrates only the lumen of an aneurysm, CT angiography also demonstrates the wall and contents of an aneurysm, including thrombus, thereby allowing a more accurate measurement of aneurysm size and the evaluation of morphologic features and surrounding structures. In this article, we discuss and illustrate common and uncommon TAAs with an emphasis on their causes, significance, CT features, and potential complications.

Definitions
The thoracic aorta consists of the aortic root, ascending aorta, aortic arch, and descending thoracic aorta (Fig 1). The ascending aorta extends from the root to the origin of the right brachiocephalic artery; the arch, from the right brachiocephalic artery to the attachment of the ligamentum arteriosum; and the descending aorta, from the ligamentum arteriosum to the aortic hiatus in the diaphragm (1). The aortic root is defined as that part of the ascending aorta that contains the valve, annulus, and sinuses (1). The arch may be subdivided into proximal (right brachiocephalic artery to left subclavian artery) and distal (left subclavian artery to attachment of the ligamentum arteriosum) segments (1). The distal arch, also referred to as the isthmus, may be narrower than the proximal descending aorta (1).

A TAA is defined as a permanent abnormal dilatation of the thoracic aorta (2). Although the aortic diameter increases slightly with age, the normal diameter of the midascending aorta should always be less than 4 cm, and that of the descending aorta no more than 3 cm (3).

Causes
Atherosclerosis is the cause of approximately 70% of all TAAs (Fig 2) (4); most of these atherosclerotic TAAs occur in the descending thoracic aorta. Because an abdominal aortic aneurysm occurs in 28% of patients with a TAA, it is important that the initial evaluation include the entire thoracoabdominal aorta (5). The causes

Table 1
Causes of TAAs

<table>
<thead>
<tr>
<th>Cause</th>
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<tbody>
<tr>
<td>Atherosclerosis</td>
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<tr>
<td>Aortic dissection</td>
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<tr>
<td>Medial degeneration (genetic)</td>
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<tr>
<td>Marfan syndrome</td>
</tr>
<tr>
<td>Ehlers-Danlos syndrome</td>
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<tr>
<td>Outside influences (acquired)</td>
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<tr>
<td>Trauma</td>
</tr>
<tr>
<td>Syphilis</td>
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<tr>
<td>Mycosis (infection)</td>
</tr>
<tr>
<td>Noninfective aortitis</td>
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<tr>
<td>Rheumatic fever</td>
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<tr>
<td>Rheumatoid arthritis</td>
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<tr>
<td>Ankylosing spondylitis</td>
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<tr>
<td>Giant cell arteritis</td>
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<tr>
<td>Relapsing polychondritis</td>
</tr>
<tr>
<td>Takayasu arteritis</td>
</tr>
<tr>
<td>Reiter syndrome</td>
</tr>
<tr>
<td>Systemic lupus erythematosus</td>
</tr>
<tr>
<td>Scleroderma</td>
</tr>
<tr>
<td>Psoriasis</td>
</tr>
<tr>
<td>Ulcerative colitis</td>
</tr>
<tr>
<td>Radiation</td>
</tr>
<tr>
<td>Behçet disease</td>
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<tr>
<td>Congenital aneurysm (rare)</td>
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Source.—Reference 6.
of TAAs are listed in Table 1 (6). The reported prevalence of TAAs varies depending on the cause. Also, accurate subclassification of aneurysms according to cause can be difficult, since it may not be possible to determine the exact cause with certainty in all cases (7). In one study of 51 TAAs with pathologic correlation, the cause was ascribed to aortic dissection in 53% of cases, atherosclerosis in 29%, aortitis in 8%, cystic medial necrosis in 6%, and syphilis in 4% (5).

Annuloaortic ectasia, a condition characterized by dilated sinuses of Valsalva with effacement of the sinotubular junction producing a pear-shaped aorta that tapers to a normal aortic arch, is most commonly associated with Marfan syndrome (Fig 3) (2,8). Other causes include homocystinuria, Ehlers-Danlos syndrome, and osteogenesis imperfecta; however, annuloaortic ectasia can be idiopathic in approximately one-third of cases.
Although the appearance of the aorta in patients with Marfan syndrome is identical to that in patients with idiopathic medial degeneration, there is a striking difference in the natural history of these two conditions, with both onset and progression being more rapid in Marfan syndrome (9).

Aneurysms due to syphilis are now rare, with effective treatment available for this infectious disease. Cardiovascular disease has been reported in up to 12% of patients with untreated syphilis, usually with a latency period of 10–30 years after the primary infection (10). Syphilitic aortitis causes focal destruction of the media with loss of elastic and smooth muscle fibers and scarring, leading to aortic dilatation and aneurysms. The most common site of these TAAs is the ascending thoracic aorta (36% of cases), followed by the aortic arch (34%), proximal descending thoracic aorta (25%), and distal descending thoracic aorta (5%). Aortic sinus involvement occurs in less than 1% of cases and is most often asymmetric, as opposed to the symmetric enlargement seen in annuloaortic ectasia (6,11). A less common manifestation of syphilitic aortitis is narrowing of the coronary ostia due to subintimal scarring, resulting in myocardial ischemia; this condition carries a poor prognosis, with an average survival time of only 6–8 months from the onset of cardiac symptoms (11). Syphilitic aneurysms are at high risk for rupture, with death due to aortic rupture reported in 40% of cases (11). Dissection is less common due to the presence of medial scar.

Figure 4. Ascending aortic aneurysm and bicuspid aortic valve in a 40-year-old woman. (a, b) Contrast-enhanced CT scan (a) and VR image (b) show an ascending aortic aneurysm. (c) Oblique axial image through the plane of the aortic valve shows the bicuspid nature of the valve.

Figure 5. Contrast-enhanced CT scan obtained in a 50-year-old man shows a retroesophageal mediastinal abscess and a mycotic pseudoaneurysm of the descending thoracic aorta (arrow).

The presence of bicuspid aortic valve is an independent risk factor for TAA formation (Fig 4; see also Movie at http://radiographics.rsna.org/cgi/content/full/29/2/537/DC1), and not merely a consequence of poststenotic dilatation secondary to aortic stenosis (12). Although aortic stenosis is a frequent complication of bicuspid aortic valve because the dysfunctional valves are prone to premature fibrosis and calcium deposition (12), aortic aneurysms associated with bicuspid aortic valve...
culosis can involve the aorta by contiguous spread from lymph nodes and spine (15).

Several causes of noninfective aortitis can lead to an aneurysm. Aortitis most commonly affects the ascending aorta in rheumatoid arthritis, ankylosing spondylitis, giant cell arteritis, and relapsing polychondritis (6). These conditions may also be associated with aortic valve insufficiency. Takayasu arteritis, a vasculitis usually encountered in Asian women, commonly affects the aortic arch and its major branches, with variable involvement of the abdominal aorta and pulmonary arteries. Although Takayasu arteritis typically causes arterial stenosis and occlusion, aneurysms may also occur (Fig 6). CT features include high attenuation of the thickened aortic wall with calcifications on

Figure 6. Takayasu arteritis in a 35-year-old woman. (a, b) Contrast-enhanced CT scans obtained at the level of the ascending (a) and distal descending (b) aorta show diffuse aortic wall thickening and an ascending aortic aneurysm. (c) VR image shows multiple areas of stenosis and aneurysm formation involving the aorta and its branches.
ties; this is particularly important with higher heart rates and in areas that move the most with cardiac motion, such as the ascending aorta. In addition, ECG gating can facilitate evaluation of at least the proximal coronary arteries (if not the entire coronary artery system) if the specified acquisition parameters provide the appropriate spatial and temporal resolution. In cases of suspected aortic dissection, it may be useful for determining coronary artery involvement. We routinely use ECG gating for the thoracic portion of our CT examinations of the aorta, which are performed on either a 16- or 64-detector CT scanner. Roos et al (19) compared ECG-gated with nongated scans of the thoracic aorta and found significant reduction in motion artifacts with the use of gating. Although motion artifacts decrease with increasing distance from the heart, the authors found significant reduction in motion artifacts for the entire thoracic aorta. However, the maximum benefit was seen at the level of the aortic valve and ascending aorta (19). We perform scanning in the craniocaudal direction, and gating is turned off at the diaphragm, which reduces the breath-hold time and radiation dose.

In the past, ECG gating has primarily been retrospective gating, with which data are collected over the entire cardiac cycle. This permits review of aortic valve morphologic features on static im-

Figure 7. Contrast-enhanced CT scan obtained in a 28-year-old man shows a posttraumatic saccular pseudoaneurysm at the aortic isthmus (arrow).
ages at end systole and end diastole, measurement of aortic valve surface area (Fig 9), and the viewing of valve leaflet motion in cine mode. Incomplete coaptation of the valve leaflets corresponds to regurgitation, and a restricted opening corresponds to stenosis (20). For example, an ascending aortic aneurysm can be associated with an unsuspected bicuspid aortic valve or calcific aortic stenosis.

However, retrospectively gated scanning is associated with a high radiation dose compared with nongated scanning. In the study by Roos et al (19), the radiation doses with retrospectively gated and nongated scanning of the thoracic aorta were 8.85 and 4.5 mSv, respectively. Scanning covered a craniocaudal range of 15 cm, with a tube potential of 120 kVp, a collimation of 1 mm, and a section width of 1.25 mm. The tube current and pitch used for gated and nongated scans were 140 mAs/1.5 and 250–400 mAs/0.38–0.75, respectively (19). Tube current modulation, with which the tube output is reduced during systole, can reduce the radiation dose associated with a retrospectively gated CT acquisition and is routinely used at our institution. A mean dose reduction of 48% for males and 45% for females has been reported with this technique (21). Also, the newer prospective triggering technique collects CT data only at a specified point or cluster of points in the cardiac cycle, reducing the time the CT beam is on to a fraction of what it was with retrospective gating, thus substantially reducing the radiation dose. The mean patient radiation dose reduction has been shown to be 77%–83% (22,23) for prospectively gated versus retrospectively gated CT angiography (with tube current modulation) of the coronary arteries performed on a 64-detector scanner.
In the evaluation of the thoracic aorta for endovascular repair, craniocaudal coverage should extend from the neck to the femoral heads. Assessment of access to the common femoral artery is essential to determine the feasibility of large-bore sheath access. Knowledge of the relationship between the aortic aneurysm and the aortic branches is necessary to assess the adequacy of the “landing zone” (the aortic segments proximal and distal to the lesion where the stent extremities will be positioned) (24). To ensure an adequate neck for graft attachment, the following conditions are desirable (25): (a) a minimum distance of 15 mm from the aneurysm to the left subclavian artery and to the celiac trunk, (b) a maximum aortic landing zone diameter of 40 mm, and (c) the absence of circumferential thrombus or atheroma within the landing zone. If the lesion is very close to the left subclavian artery, it may be necessary to cover the origin of the subclavian artery to ensure an adequate landing zone; however, patency of both vertebral arteries must be demonstrated prior to the procedure (25). For the assessment of stent-graft repair of aortic aneurysms, it is important that delayed views be evaluated for endoleak. We typically acquire these views 60 seconds after the arterial phase acquisition.

**CT Data Manipulation**

CT is the primary modality for evaluating abnormalities of the thoracic aorta. Multidetector CT,

Table 2

<table>
<thead>
<tr>
<th>Anatomic Locations of Measurements in a Standard Report Describing the Thoracic Aorta</th>
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<tbody>
<tr>
<td>Sinus</td>
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<tr>
<td>Sinoaortic junction</td>
</tr>
<tr>
<td>Midascending aorta (midpoint between sinoaortic junction and proximal aortic arch)</td>
</tr>
<tr>
<td>Proximal aortic arch (aorta at origin of brachiocephalic trunk)</td>
</tr>
<tr>
<td>Midaortic arch (just distal to left common carotid artery)</td>
</tr>
<tr>
<td>Proximal descending aorta (2 cm distal to left subclavian artery)</td>
</tr>
<tr>
<td>Middescending aorta</td>
</tr>
<tr>
<td>Aorta at diaphragm (2 cm above celiac axis origin)</td>
</tr>
<tr>
<td>Abdominal aorta at celiac axis origin</td>
</tr>
<tr>
<td>Abdominal aorta at most cephalic renal artery</td>
</tr>
<tr>
<td>Abdominal aorta at most caudal renal artery</td>
</tr>
<tr>
<td>Infra renal abdominal aorta (15 mm below most caudal renal artery)</td>
</tr>
<tr>
<td>Aorta just above bifurcation</td>
</tr>
<tr>
<td>Aneurysm (maximum diameter [location specified])</td>
</tr>
</tbody>
</table>

with its multiplanar capability, can be used to evaluate an aneurysm in any plane, determine its size and morphologic features, clarify its relationship to branch vessels, evaluate its effect on adjacent structures, and identify complications such as dissection and rupture. These options give multidetector CT a decided advantage over conventional angiography, which provides information primarily about the aortic lumen. In a series of examinations
that included 33 thoracic aneurysms, three ruptured TAAs, six penetrating atherosclerotic ulcers, five aortic dissections, and two pseudoaneurysms, Quint et al (26) demonstrated that CT has a 92% accuracy for diagnosing abnormalities of the thoracic aorta. In addition, CT correctly helped predict the need for hypothermic circulatory arrest during surgical repair in 94% of patients (26).

Although axial sections are still the mainstay of interpretation, two-dimensional and three-dimensional reformating techniques such as maximum intensity projection, curved planar reformation, multiplanar reformation, and VR may facilitate interpretation and improve communication with referring physicians (27). To our knowledge, it has not been scientifically shown that the use of these tools increases diagnostic accuracy or diagnostic confidence. For example, in the study by Quint et al (26), the use of multiplanar reformatted images along with axial images changed the interpretation in only one case. It should be noted that their study involved CT examinations performed on single-section helical scanners and interpreted by thoracic radiology specialists, who may be more experienced in the evaluation of thoracic CT examinations.

Double oblique reformatted images obtained perpendicular to the aortic lumen (ie, true short-axis images of the aorta) allow more accurate measurement of aortic diameter than does relying on axial CT scans, on which the aorta has an oblique course (Fig 10) (28). Our standard report describing the thoracic aorta includes measurements of aortic diameter (mean, minimum, and maximum) at specific locations (Table 2), allowing documentation of size at these locations and change over time. A potential drawback to using the measurements obtained from the more recently available double oblique reformatted images is the fact that data regarding aortic size and risk of rupture are based on measurements taken from axial sections (28). Curved planar reformatted images may be useful in aneurysms with dissection, depicting the ostia of aortic branches with respect to the intimal flap.

Aneurysm Morphologic Features

TAAs can be classified as either true aneurysms or false aneurysms (pseudoaneurysms). True aneurysms contain all three anatomic layers—the intima, media, and adventitia—are usually associated with fusiform dilatation of the aorta, and are most commonly due to atherosclerosis. Although the majority of atherosclerotic aneurysms are fusiform, up to 20% may be saccular (6). Pseudoaneurysms have fewer than three layers and are contained by the adventitia or periaortic tissues. They are typically saccular with a narrow neck, and are most commonly due to trauma (Fig 7), penetrating atherosclerotic ulcers, or infection (mycotic aneurysms) (4).

The location of an aneurysm can provide a clue to its cause. In a study of 249 aneurysms of the aorta and its branches by Fomon et al (7), most of the aneurysms were found in the abdominal aorta (30.9% of cases), whereas the TAAs were most frequently seen in the ascending aorta (22.1%). Arch aneurysms, descending aortic aneurysms, and thoracoabdominal aneurysms were seen in 11.6%, 7.6%, and 2.8% of cases, respectively (7).

Involvement of the ascending aorta alone is usually associated with annuloaortic ectasia, syphilis, postoperative aneurysms (at the aortic suture line or at the site of aortic cannulation), aortic valve disease, or infectious or noninfectious aortitis. In contrast, atherosclerosis is a more diffuse process and rarely involves only the ascending aorta (4). Postoperative ascending aortic pseudoaneurysms can occur at an aortotomy site, cannulation site for cardiopulmonary bypass, or needle puncture site (needle inserted for pressure measurement, to purge the aorta of air, or to inject cardioplegic solution), or at incompetent suture lines (29,30). Cross-clamping an atherosclerotic ascending aorta may also cause an iatrogenic aortic dissection or pseudoaneurysm (30). Figure 11 shows the potential sites of these postoperative
Figure 12. Ductus diverticulum in a 35-year-old man. The entity was seen at CT angiography of the thoracic aorta. Axial (a) and sagittal reformatted (b) CT images show a focal convex bulge (arrow) along the anterior aspect of the isthmus. Note the obtuse angles with the aortic wall, unlike with a pseudoaneurysm.

ascending aortic pseudoaneurysms. Saccular traumatic aneurysms are most common at the aortic isthmus, whereas those secondary to penetrating ulcers can occur anywhere in the descending aorta.

TAA Mimics
It is important to be aware of normal variants that can mimic an aortic aneurysm, two of which are ductus diverticulum and aortic spindle.

Ductus Diverticulum
Ductus diverticulum consists of a convex focal bulge along the anterior undersurface of the isthmic region of the aortic arch (31). Although ductus diverticulum is commonly believed to be a remnant of the closed ductus arteriosus, it has been suggested that this entity may actually represent a remnant of the right dorsal aortic root (32). It is particularly important to differentiate ductus diverticulum from a posttraumatic aortic pseudoaneurysm, which most commonly occurs at the aortic isthmus. In contrast to a pseudoaneurysm, ductus diverticulum has smooth margins with gently sloping symmetric shoulders and forms obtuse angles with the aortic wall (Fig 12) (31).

Aortic Spindle
Aortic spindle is a smooth, circumferential bulge below the isthmus in the first portion of the descending aorta (Fig 13) and should not be confused with an aneurysm.

Complications
Rupture
The risk of rupture of TAA s increases with the size of the aneurysm (31). This is in accordance with the law of Laplace, which states that wall tension increases with the diameter of the aorta. Elective aneurysm repair has a lower mortality rate (9%) than does emergent repair (22%); therefore, aneurysms are considered for repair when they are either symptomatic or exceed 5–6 cm in diameter (33–35). Coady et al (36,37) described the median size of rupture-dissection of ascending and descending aortic aneurysms as 5.9 and 7.2 cm, respectively, and advocated surgical intervention for ascending TAAs exceeding 5.5 cm and for descending TAAs exceeding 6.5 cm. Earlier intervention is recommended in patients with Marfan syndrome and is advocated at an aortic diameter of 5 cm (36). It is important to monitor the size of aneurysms with CT annually, since there is variability in the annual growth
Figure 13. Aortic spindle. Three-dimensional VR image shows an aortic spindle (arrow) as a circumferential bulge in the proximal descending thoracic aorta.

Figure 14. Aneurysm rupture in a 65-year-old man. Nonenhanced CT scan shows a ruptured atherosclerotic aneurysm of the descending thoracic aorta. Note the high-attenuation fluid in the left pleural space, a finding that represents acute hemothorax.

a. b.

Figure 15. Abdominal aortic aneurysm in a 75-year-old man. Nonenhanced (a) and contrast-enhanced (b) CT scans show a high-attenuation crescent in the mural thrombus of an aortic aneurysm, a sign of impending rupture or contained leak.

rate of aneurysms (0.07–0.42 cm) (31,33). An annual growth rate greater than 1 cm is an accepted indication for surgical repair (38).

CT is the modality of choice for identifying aneurysm rupture. Aortic aneurysms can rupture into the mediastinum, pleural cavity (Fig 14), pericardium, or adjacent luminal structures such as the airway or esophagus, manifesting as a high-attenuation hematoma on nonenhanced scans and even as contrast material extravasation from the aortic lumen on contrast-enhanced scans. A high-attenuation “crescent” in the mural thrombus of a TAA may represent an acute contained or impending rupture, analogous to that described in abdominal aortic aneurysms (Fig 15) (2,39). Another sign
aortobronchial fistula, which manifests clinically as hemoptysis (4) and at CT as consolidation in the adjacent lung due to hemorrhage (Fig 16); the fistulous communication itself is not commonly seen at CT (41). Most aortobronchial fistulas (90%) occur between the descending aorta and the left lung (42). Communication with the esophagus (aortoesophageal fistula) is less common.

Figures 16, 17. (16) Aortobronchial fistula in a 50-year-old man with hemoptysis. Contrast-enhanced CT scan shows a focal rupture of the descending TAA, consolidation in the adjacent left lower lobe of the lung, and endobronchial blood in the left lower lobe segmental bronchus (arrow), findings that are compatible with an aortobronchial fistula. (17) Aortoesophageal fistula in a 73-year-old man. Nonenhanced (a, b) and contrast-enhanced (c) CT scans show an aortoesophageal fistula and intraesophageal rupture of a saccular descending TAA. High-attenuation blood is seen within the mediastinum in a and within the esophagus in b.

of contained rupture is the “draped aorta sign,” wherein the posterior aortic wall is closely apposed to the spine; this condition is thought to be a consequence of a deficient aortic wall (40). A TAA can develop fistulous communication with the tracheobronchial tree, known as an aortobronchial fistula, which manifests clinically as hemoptysis (4) and at CT as consolidation in the adjacent lung due to hemorrhage (Fig 16); the fistulous communication itself is not commonly seen at CT (41). Most aortobronchial fistulas (90%) occur between the descending aorta and the left lung (42). Communication with the esophagus (aortoesophageal fistula) is less com-
mon and is usually associated with hematemesis and dysphagia (43). An aortoesophageal fistula is a catastrophic complication whose CT findings include mediastinal hematoma, an intimate relationship of the aneurysm to the esophagus, and, rarely, contrast material extravasation into the esophagus (Fig 17) (2).

Compression of Adjacent Structures
TAAs can be asymptomatic, but when large enough, they can produce symptoms by compressing adjacent structures—for example, superior vena cava syndrome due to compression of the superior vena cava, stridor or dyspnea due to airway compression, hoarseness due to compression of the recurrent laryngeal nerve, and dysphagia due to esophageal compression (6).

Postoperative Imaging
The normal postoperative appearance of the thoracic aorta can be confusing and may mimic disease; hence, knowledge of surgical details is of paramount importance prior to interpretation. The type of surgical repair used is based on a variety of factors, including disease extent, status of the aortic tissue and valve, preference of the patient and surgeon, need for long-term anticoagulation therapy, and type of prior surgery (if applicable) (44). Aortic grafts may be tissue (porcine) grafts or synthetic in nature. Tissue grafts are indistinguishable from native aortic tissue at CT, whereas synthetic grafts have a higher attenuation that is readily seen at nonenhanced CT (44). Two common techniques of aortic root graft repair are interposition graft and inclusion graft (1).

After the diseased segment has been excised, an interposition graft is sewn end to end and vascular branches (such as coronary arteries) are reimplanted. Felt rings and pledgets are often used to reinforce the site of anastomosis and the site of cannula placement. These objects can mimic pseudoaneurysms on contrast-enhanced scans but can easily be identified because of their high attenuation on nonenhanced scans.

An inclusion graft is inserted into the aortic lumen, leaving a potential space between the native aorta and the graft that may thrombose or even show persistent blood flow (Fig 18). In the absence of hemodynamic instability, blood flow in the perigraft space does not require intervention (1).

When the descending aorta is repaired with a graft, the native aorta may be left in situ and appears as an irregular curvilinear area of dense calcification or a rind of soft tissue, often with fluid between it and the graft (44).

Complications that should be monitored in the postoperative period include graft dehiscence and infection. Dehiscence of the surgical suture line may lead to pseudoaneurysm formation, which can also involve the reimplanted coronary arteries (1).

The “elephant trunk” technique is used in patients with diffuse aneurysmal disease and involves graft replacement of the ascending aorta and aortic arch with or without valve replacement. The free segment of the graft is left projecting into the proximal descending aorta,
Endovascular repair of the thoracic aorta is an alternative surgical procedure in poor surgical candidates or in emergency situations (1). A combined endovascular-surgical procedure can be performed in patients with aortic arch involvement to allow treatment of a wider range of conditions.
patients (25). Postprocedure CT angiography is usually performed at the time of discharge; 3, 6, and 12 months from the time of the procedure; and annually thereafter (1).

A unique complication of endovascular repair is an endoleak, defined as contrast enhancement outside the stent-graft. Endoleaks have been divided into four types on the basis of the source of blood flow: type I, leak at the attachment site; type II, leak from a branch artery; type III, graft defect; and type IV, graft porosity (Figs 20, 21) (1). Unlike in the infrarenal aorta, type 2 endoleak is uncommon in the thoracic aorta and type 1 is more prevalent (1,45). There are several CT findings that may help distinguish between different types of endoleaks. Type 1 endoleak is seen communicating with the proximal or distal attachment site of the stent-graft, whereas type 2 endoleak is located in the periphery of the aneurysm sac without contact with the stent (45). CT can also help visualize vessels in communication with the endoleak cavity (Fig 21); however, contrast enhancement in these vessels may represent inflow (as in type 2 endoleak) or outflow (from endoleaks other than type 2). Type 3 endoleaks usually manifest around the graft while sparing the sac periphery (46). When type 3 endoleaks are suspected, CT can be used to evaluate for stent-graft integrity as well. Type 4 endoleaks secondary to graft porosity are uncommon with today’s stent-grafts and are identified as a “blush” on the immediate postdeployment angiogram when the patient is fully anticoagulated (45). The diagnosis of type 4 endoleak is one of exclusion (45), since other types of endoleak can be present on the postimplantation angiogram and should be excluded.

Identification of the correct type of endoleak has important treatment implications. Type 1 and type 3 endoleaks are repaired immediately, the former by securing the attachment sites with angioplasty balloons, stents, or stent-graft extensions and the latter by covering the defect with a stent-graft extension (45). The management of type 2 endoleak is controversial, and, although some authors follow up this type of endoleak as long as the size of the aneurysm does not increase, others prefer to repair it (45). Type 4 endoleaks are self-limited, require no treatment, and resolve with normalization of the patient’s coagulation status (45).

Aneurysm expansion without endoleak is known as endotension or type 5 endoleak (45). Although the exact cause of endotension is unknown, possible causes include an endoleak that cannot be visualized with traditional imaging techniques, ultrafiltration of blood across the graft, and thrombus providing an ineffective barrier to pressure transmission (45).

**Conclusions**

Multidetector CT angiography is routinely used to evaluate the spectrum of TAAAs. Knowledge of the causes, significance, imaging appearances, and potential complications of both common and uncommon aortic aneurysms is essential for prompt and accurate diagnosis.

**References**


Multidetector CT of Thoracic Aortic Aneurysms
Prachi P. Agarwal, MD, et al

The presence of bicuspid aortic valve is an independent risk factor for TAA formation...and not merely a consequence of poststenotic dilatation secondary to aortic stenosis.

Knowledge of the relationship between the aortic aneurysm and the aortic branches is necessary to assess the adequacy of the “landing zone” (the aortic segments proximal and distal to the lesion where the stent extremities will be positioned).

In contrast to a pseudoaneurysm, ductus diverticulum has smooth margins with gently sloping symmetric shoulders and forms obtuse angles with the aortic wall.

Elective aneurysm repair has a lower mortality rate (9%) than does emergent repair (22%); therefore, aneurysms are considered for repair when they are either symptomatic or exceed 5-6 cm in diameter.

Knowledge of the surgical procedure can prevent mistaking the free segment of the graft for a dissection flap.