Acute Aortic Syndrome in Adults: Evidence-Based Emergency Imaging

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Key Points

- Acute aortic syndrome encompasses four (nontraumatic) acute aortic pathologies: aortic dissection, intramural hematoma, penetrating atherosclerotic ulcer, and aortic rupture.
- CT angiography is the gold standard for rapid diagnosis and treatment planning in patients with suspected acute aortic syndrome (strong evidence).
- MRI/MRA of the aorta is an appropriate alternative to CT angiography in selected clinical situations (strong evidence).
- The "triple-rule-out" CT angiogram can be performed safely and effectively, but its increased radiation dose, contrast burden, and higher nondiagnostic image quality preclude its widespread acceptance as a first-line imaging modality in patients presenting to the emergency department with undifferentiated chest pain (limited evidence).

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Definition and Pathophysiology

The term "acute aortic syndrome" (AAS) encompasses a variety of different but related conditions, including aortic dissection (AD), acute intramural hematoma (IMH), penetrating atherosclerotic ulcer (PAU), and frank aortic rupture [1]. Definitions and descriptions of these varied syndromes in the medical and surgical literature in general, and the radiologic literature in particular, are challenging, as they are related and overlapping syndromes. Also, various authors have used variable descriptors in the literature. Our understanding of the underlying pathophysiology of these interrelated diseases has also evolved over the decades and centuries since aortic dissection was first described in 1819 by Rene Laennec [2].

The terms "aneurysm" and "dissection" have become irrevocably intertwined [2], although they represent two separate but intimately related disease processes. An aortic "aneurysm" is a fixed dilatation of the vessel greater than 1.5 times its expected diameter, which is usually asymptomatic, and, if asymptomatic, is followed over time until it reaches a size large enough that warrants intervention. An aortic "dissection," on the other hand, is a tear in the intimal lining of the aorta, which allows blood to dissect into the media (middle layer) of the wall of the aorta. It is usually exquisitely painful when it initially occurs, and is a life-threatening emergency,

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which requires emergent medical and/or surgical or endovascular therapy. Once a dissection occurs, the separation between the intima and media can extend retrograde (back toward the heart) and result in coronary artery occlusion, hemopericardium, and tamponade and/or antegrade throughout the thoracoabdominal aorta and its branches, resulting in occlusions of the head and neck vessels (and subsequent stroke), and renal and visceral arteries, resulting in end-organ ischemia.

The presence of an aortic aneurysm increases the risk of subsequently developing a dissection or rupture. Aneurysms exceeding 6 cm in size have a yearly rate of these complications of at least 7% [3]; aortic dissection similarly increases the risk of subsequent aneurysm formation, but they are distinct entities. Aortic aneurysms can exist without dissection, and dissection can occur without aneurysmal dilatation [4]. Dissections are typically classified using the Stanford or DeBakey classification systems. In the more commonly used Stanford system, a "Type A" dissection is any dissection that involves the ascending aorta (whether it extends into the arch and/or descending thoracic aorta), whereas a "Type B" dissection does not involve this portion of the aorta [4].

One proposed common pathway for the development of aneurysm and/or dissection, particularly in the ascending aorta, has been medial degeneration (previously called "cystic medial necrosis"), which represents loss of the extracellular matrix and smooth muscle in the media of the aortic wall [4, 5]. Cystic medial degeneration can occur idiopathically or in association with systemic hypertension, connective tissue disorders (such as Marfan syndrome and Ehlers-Danlos), aortitis (such as giant cell arteritis), and bicuspid aortic valve [6, 7].

Acute intramural hematoma is defined as acute (thrombosed) blood within the wall of the aorta, without the presence of an intimal flap or tear [8, 9]. The pathophysiology is typically attributed to rupture of the vasa vasorum (the small vessels which supply the wall of the aorta) leading to hemorrhage into the wall of the aorta, without associated intimal disruption [10]. This can occur spontaneously (e.g., in association with hypertension) or in conjunction with a penetrating atherosclerotic ulcer. A classic aortic dissection with thrombosis of the false lumen is a separate clinical entity, but distinguishing between these two entities on imaging studies is often difficult if not impossible [10]. Features of IMH that place the patient at higher risk for complications (aneurysmal dilatation, dissection, or rupture) include the presence of an ulcer-like projections, aneurysmal enlargement, pronounced thickness of the hematoma (>11–16 mm), and intramural blood pools [11]. While often treated in a similar manner to acute dissection, the natural history of acute IMH is uncertain, with regression seen in approximately 10% of patients, progression to classic dissection in 28–47% of patients, and an estimated risk of rupture of 20–45% [12].

Penetrating atherosclerotic ulcers (PAUs) represent an atherosclerotic plaque that has disrupted the internal elastic lamina and extends into the media of the aortic wall [13–16], without a visible intimal dissection flap. This disruption of the intima by the PAU can lead to development of an acute IMH, classic dissection, pseudoaneurysm formation, or frank rupture. Symptomatic PAUs are included in the acute aortic syndrome spectrum and are generally treated urgently, with rates of rupture as high as 38% [15]. However, with the increasing use of cross-section imaging, more asymptomatic PAUs or "ulcer-like" projections of the aorta are being discovered in otherwise asymptomatic patients. These patients are often elderly and are imaged for other reasons entirely. They have lower rates of rupture and disease progression [15, 17].

The imaging features of these complex diseases often overlap and coexist, but some general patterns and radiographic definitions exist. Aortic dissection appears as a distinct intimal flap within the lumen of the aorta, with a "true" and "false" lumen, which typically enhances following intravenous contrast administration unless thrombosed. The site of intimal tear (fenestration) may or may not be visible. Acute intramural hematoma is characterized on CT (and MRI) by the presence of crescentic high attenuation in the wall of the aorta (which is often more conspicuous prior to intravenous contrast administration) and lack of enhancement following intravenous contrast administration. Aortic rupture and impending rupture are present when there is stranding and ill-defined soft tissue surrounding the aortic wall, mediastinal or pleural hemorrhage, or frank extravasation of contrast outside the wall of the aorta (Fig. 14.5a, b). Penetrating atherosclerotic ulcers are seen as focal contrast-filled outpouchings through the wall of the aorta, without a visible dissection flap, in the presence of diffuse aortic atherosclerotic disease [13, 15, 17].

Epidemiology

According to a large autopsy series from Sweden including almost 30 years of data, the incidence of aortic dissection is 3.2 per 100,000, with an incidence of aortic rupture of 0.9–1.0 per 100,000 [18]. Risk factors for aortic aneurysm and dissection are similar, and include age, systemic hypertension, atherosclerosis, vasculitides such as Takayasu's and Giant cell arteritis, bicuspid aortic valve, and inherited connective tissue disorders such as Marfan, Loeys-Dietz, Ehlers-Danlos, and Turner syndromes [5, 6, 19]. Pregnancy is also a risk factor for aortic dissection [20]. In the large International Registry of Acute Aortic Dissection (IRAD) database, established in 1996 and encompassing 17 years and 28 centers, 67% of patients enrolled presented with Type A dissection and 33% with Type B dissection, with mean ages of 62–64 years [21]. Two thirds of the patients were men [21]. Over 17 years of the study, in hospital mortality for Type A dissection improved significantly from 31% to 22%, and in-hospital mortality for Type B dissection remained stable at 12–14% [21]. In the classic paper by Hirst et al. in 1958, Type A dissections have a mortality rate of 1–2% per hour and are thus treated with emergent surgery [22]. Type B dissections (without evidence of end-organ compromise) are generally treated with medical management (see below).

Overall Cost to Society

Limited data exists on the overall costs to society of the acute aortic syndromes. While mortality from AAS is high, the overall incidence is orders of magnitude less compared to more common causes of chest pain. For example, the IRAD investigators note that coronary artery disease is 100–200 more common than aortic dissection, with an estimated incidence of three aortic dissections for every 1000 patients presenting with chest and/or back pain [12].

Goals of Imaging

The primary goal of imaging in patients with acute aortic syndrome is to (1) diagnose the underlying aortic pathology, (2) identify any associated conditions or complications which may be present, and (3) provide adequate information for subsequent medical, open surgical, and/or endovascular aortic repair.

Methodology

A comprehensive PubMed search for articles published between 1990 and July 2015 using the PubMed search engine was performed using a combination of the following key terms: acute aortic syndrome, aortic dissection, aortic aneurysm, penetrating ulcer, CT, MR, angiography, and triple rule out.

Discussion of Issues

What Is the Imaging Modality of Choice in Patients with Suspected Acute Aortic Syndrome?

Summary of Evidence Computed tomography angiography (CTA) is the gold standard for imaging of suspected acute aortic syndrome. It is readily available in most if not all emergency departments in the developed world, can be obtained relatively rapidly, and provides excellent spatial resolution not only for diagnosis but also for subsequent treatment planning (strong evidence).

Supporting Evidence

Chest Radiography

Chest radiography is often performed in patients presenting to the emergency department with chest pain and is recommended in all patients presenting with symptoms suspicious for acute aortic syndrome [19, 23]. However, it is used primarily as a means of discovering alternative causes of acute chest pain (such as pneumothorax). It is specifically noted that the chest radiograph should not to be the definitive test for acute aortic syndromes. Historically, findings of aortic dissection and aneurysm were described on chest radiographs as mediastinal widening, displaced intimal calcifications, and changes in the configuration of the aorta over successive radiographs [24]. A study, performed in the modern era, assessed mediastinal width on posteroanterior (PA) and anteroposterior (AP) radiographs in 100 patients with confirmed nontraumatic thoracic aortic dissection and 120 patients with confirmed normal aortas [25]. The authors found that PA radiographs were both more sensitive and specific than AP radiographs, as would be expected due to less magnification on PA radiographs, and found utility in both the maximal mediastinal width (a cutoff of 7.5 cm on PA films was 90% sensitive and 88% specific), as well as the maximal left mediastinal width (a cutoff of 5 cm was 90% sensitive and 90% specific) [25]. Chest radiography is therefore useful in uncovering other causes of acute chest pain and may suggest the diagnosis of aortic dissection. However, in any patient with suspected AAS, further cross-sectional imaging is required to definitely exclude AAS [19, 23]. CT and MRI also have the ability to guide surgical and/or endovascular management in confirmed cases of AAS.

CT Angiography

CT angiography has become the mainstay for diagnosis of suspected AAS in the United States. In the IRAD, data from 4428 patients revealed that over a span of 17 years, the frequency of CT utilization increased from 46% to 73% for the detection of Type A dissection, while the use of transesophageal echocardiography (TEE) decreased from 50% to 23% [21]. CT angiography is fast, with scanners readily available in most modern emergency departments. CT can provide an overview of the entire thoracic (and abdominal) aorta in one data set, along with information about potential complications. A CT angiogram provides excellent spatial resolution for 3D reconstructions, which can be critical in planning surgical and endovascular repair of AAS.

Much of the data on sensitivity and specificity of CT for the diagnosis of aortic dissection and other AAS comes from older literature, with studies performed on older equipment with less resolution and slower scan times compared to modern machines. Previously reported sensitivities of 90–100% and specificities of 87–100% [23] are now likely close to 100% with current multi detector CT scanners [26].

When performing a CT angiogram for suspected AAS, a precontrast exam of the thorax is often obtained to assess for the presence of IMH. Intramural hematoma has classically been described as crescentic high attenuation in the wall of the aorta, which can potentially be mistaken for wall thickening (or even overlooked) on post-contrast images. However, a newer retrospective study by Lovy et al. found a sensitivity of 100% for IMH on the post-contrast material-enhanced CTA exam, suggesting that unenhanced imaging may not always be necessary [27]. In addition, a retrospective study by Knollmann et al. similarly found that IMH was visible on post-contrast CTA images in all 31 of their cases [28]. Whether pre-intravenous contrast material-enhanced images are obtained routinely for all suspected AAS patients is generally a matter of institutional preference. If they are routinely performed, they should be limited in *z*-axis coverage, extending from the top of the arch to the bottom of the heart to limit radiation exposure.

After the precontrast exam is performed, a CT angiogram is performed, typically extending from the thoracic inlet to the diaphragmatic hiatus. Optimal contrast enhancement of the aorta (>250 Hounsfield units) can be obtained utilizing either a timing run or bolus tracking, with an injection rate of 4–5 mL/s [29]. The volume of iodinated contrast utilized will depend on several factors, including patient size and the pitch of the CT machine, but is typically in the range of 60–120 mL. Reconstructed images should include coronal and sagittal images, for evaluation of the aortic arch, and axial data sets at no more than 1–2 mm thickness to allow for adequate multiplanar and 3D volume rendering. CT technology has advanced rapidly in the last few decades. Newer technologies, such as EKG synchronization, high temporal resolution "high-pitch" acquisition modes, and dual-energy imaging, are discussed in more detail below.

As with most radiological exams, detection and subsequent management of incidental findings are an important issue to consider. CT angiograms of the chest include not only the aorta but the heart, lungs, chest wall, and upper abdomen, where incidental (but potentially life-altering) findings can occur. In a recent retrospective review of 370 CTAs performed to evaluate for AAS, 329 patients (89%) had at least one incidental finding, and 106 (29%) had recommendations for some form of follow-up [30]. Most of these (44%) were for pulmonary nodules, but other findings included pneumonia, pleural and pericardial effusions, and cancer and/or metastases [30].

Magnetic Resonance Imaging

MR angiography, while an excellent modality for evaluating the aorta, is not typically the first test of choice in suspected AAS, for several reasons [21]. First, MRI is not nearly as readily available as CT, and even when available, may not be available 24 h a day. MR angiograms take significantly longer to perform than CT angiograms, which is an issue in potentially unstable patients with suspected AAS. Patient cooperation is required, as most MR sequences require breath-holding to minimize artifact. Claustrophobia can limit the patient's willingness to cooperate with the exam. When it is available and the patient deemed appropriate, a focused MR exam including steady-state free precession (SSFP) axial and coronal images, cine SSFP oblique sagittal images, and contrast-enhanced 3D MRA (CE-MRA) could be performed in 4 minutes, with reported 100% accuracy for determining the presence or absence of dissection or aneurysm [31]. In cases of suspected acute IMH, T1-weighted black blood (BB) images can demonstrate intermediate or high signal within the wall of the aorta [32].

In patients who cannot reliably hold their breath or who cannot receive gadolinium-based contrast agents due to significant renal dysfunction, the development of unenhanced SSFP MR angiography is a viable alternative [33–35]. With these sequences, the patient breathes freely while a special "navigator" sequence monitors the position of the diaphragm, only utilizing data when the diaphragm is within a certain narrow window [33]. These sequences can also be performed with EKG gating, allowing for visualization of intracardiac structures and the proximal coronary arteries, which are typically not well seen on conventional non-EKG-gated MR angiography. In a comparison of 30 consecutive patients who underwent both EKG-gated free-breathing SSFP MRA and conventional MRA, the SSFP sequence performed excellently [36].

Echocardiography

Echocardiography is a useful modality in the diagnosis of aortic dissection. Transthoracic (TTE) and transesophageal (TEE) echocardiography offer real-time acquisition, which can be obtained at the bedside, a significant advantage over CT and MRI in hemodynamically unstable patients. Reported sensitivities for detection of dissection range from 59 to 85% and specificities from 93 to 96% [23]. In a large meta-analysis of 16 studies involving 1139 patients, Shiga et al. found that TEE, CT, and MRI all yielded equally reliable diagnostic accuracy for confirming or excluding thoracic aortic dissection [37]. However, there are some important limitations with echocardiography. An experienced operator must be available to obtain and interpret the images, as echocardiography can suffer from a number of potential artifacts. Transthoracic echocardiography is limited by the availability of acoustic windows and can be affected by abnormal chest wall configuration, obesity, and pulmonary emphysema [38, 39]. Transesophageal echocardiography is a more invasive procedure and can image nearly the entire thoracic aorta, but there is a known "blind spot" in the anterior portion of the aortic arch, caused by artifact from the trachea and left main stem bronchus as they pass between the probe (in the esophagus) and aorta [38]. The full extent of a dissection, including involvement of the abdominal aorta, iliac vessels, and visceral branches, is not as readily apparent compared to CT or MRI. Despite these limitations, echocardiography remains a key modality in the management pathway, both in the United States and Europe [23, 39].

PET/CT

While metabolic imaging of the aorta, with ^{18}FDG PET/CT, is not a first-line diagnostic test for patients with suspected AAS, there is limited evidence that PET/CT of the aorta can be useful in a few specific clinical situations. In a small study by Reeps et al., imaging findings of nine patients with known acute dissection and two patients with symptomatic progressive dissection were compared with those of seven patients with known chronic stable Type B dissection. The standardized uptake value (SUV) of the aortic wall or dissection membrane was found to be significantly higher in all of the acute or progressive dissection cases compared to the chronic dissection cases [40]. Thus, PET/CT could have a role resolving whether a newly diagnosed aortic dissection is in fact acute or chronic, in patients who present with atypical or nonclassic symptoms. Metabolic imaging may also have a role in assessing prognosis; a study of 28 patients by Kato et al. demonstrated that higher SUV values in the wall of the aorta in dissection patients were significantly associated with an increased risk for progression and rupture [41]. However, larger scale studies would be required before either of these assertions could be generalized for routine clinical practice.

What Newer CT Technologies Are Being Utilized in Imaging of Suspected Acute Aortic Syndromes?

Summary of Evidence Most modern CT scanners are capable of EKG synchronization, which can reduce or eliminate pulsation artifact in the ascending aorta and allow accurate assessment of the coronary arteries and aortic valve. However, CTA protocols utilizing EKG synchronization should be carefully tailored to minimize the increased radiation dose. Dual-source scanners are capable of high-pitch acquisition modes, which can eliminate pulsation artifact while minimizing radiation dose. Dual-energy techniques are available for generation of virtual noncontrast (VNC) images, potentially eliminating the need for a precontrast scan (thereby reducing radiation dose), but their routine use in suspected AAS may be complicated by higher levels of artifact (limited evidence).

Supporting Evidence

EKG Synchronization

EKG synchronization refers to placing electrodes on the patient's chest during the CT exam and acquiring and reconstructing images during specific phases of the cardiac cycle (one R-to-R interval). EKG synchronization can be performed retrospectively, in which data from all cardiac cycles (systole and diastole) is acquired and then "retrospectively" reconstructed at specific phases (usually in 10% increments from 0% to 90% of the R-to-R interval). Alternatively, EKG synchronization can be performed utilizing prospective triggering, in which data only from specific parts of the cardiac cycle (typically at about 30% of the R-to-R interval for systole or about 70% of the R-to-R interval for diastole) is acquired "prospectively" at preselected locations, and imaging is optimized or acquired for some phases of the cardiac cycle. Prospective EKG triggering results in significant dose reduction to the patient [42], but is more likely to result in artifact at higher heart rates and in patients with cardiac ectopy.

The primary advantage of EKG synchronization over conventional CT angiogram is the reduction or elimination of cardiac motion and pulsation artifact in the ascending aorta. With EKG synchronization, the lumen of the coronary arteries can be assessed, and aortic valve leaflets can be visualized [43]. A study by Roos et al. showed a clear reduction in motion artifact with EKG-synchronized CTA compared to conventional CTA, but did not comment on the difference in radiation dose [44]. A more recent study by Schernthaner et al. showed a significant reduction in motion artifact, an increase in diagnostic confidence, with EKG-synchronized CTA performed with the same radiation dose as conventional CTA [45]. The routine use of EKG synchronization for suspected AAS is not universal, however, and while some consider it an integral part of their protocol [29], its use varies among institutions.

High Pitch

With the introduction of dual-source CT scanners, high-pitch acquisition protocols (with pitch up to 3.2) have been developed which allow for very fast imaging of the entire chest, in under one second [46, 47]. These can be performed with EKG synchronization (i.e., timed for a specific phase of the cardiac cycle), but even without EKG synchronization, the sub-second scan time is enough to significantly reduce or eliminate pulsation artifact in the ascending aorta, which is a common pitfall that can mimic a Type A dissection flap [29, 43]. In a study of 51 consecutive patients with undifferentiated acute chest pain, an EKG-synchronized high-pitch protocol provided excellent image quality with low radiation dose (average 3.8 mSv) [46]. Beta-blockers were not routinely administered prior to the exam. When patients had heart rates of 65 beats per minute or less, the image quality was excellent, but did degrade significantly at higher heart rates. Importantly, image noise can increase significantly when using high- pitch protocols in patients with a large body habitus [47].

Dual Energy

With the introduction of dual-source CT scanners, the concept of dual-energy CT emerged [48]. By operating the two tubes at different kVp (typically one at a low energy of 80–100 kVp and the other at a higher energy of 140–150 kVp) and comparing the differences in X-ray attenuation within a voxel between the two sources, the amount of iodine within the voxel can be quantified [49]. This is particularly useful when imaging the aorta, because it allows for the creation of virtual noncontrast (VNC) images (potentially avoiding a precontrast scan and reducing radiation dose) [50, 51]. The replacement of a precontrast scan with VNC images from a dual-energy scan has been studied in the setting of follow-up imaging after thoracic endovascular aortic repair (TEVAR), with excellent results [52, 53]. However, its routine use in the setting of suspected AAS is less well established. One recent study comparing VNC images of the thoracic aorta to the abdominal aorta found VNC images tend to be prone to pulsation artifact [54]. In fact, while VNC images were deemed an acceptable replacement for conventional precontrast images in 93% of cases of the abdominal aorta, they were acceptable in only 12% of thoracic aorta cases [54].

What Is the Role of the "Triple-Rule-Out" Examination?

Summary of Evidence The "triple-rule-out" (TRO) CTA typically requires higher radiation dose and more iodinated contrast and is more difficult to perform, compared to conventional coronary CTA or CTA of the aorta or pulmonary arteries alone. While it may be quite useful in selected clinical situations, its routine use in patients with undifferentiated chest in the emergency department is not yet justified (limited evidence).

Supporting Evidence Patients presenting to the emergency department with chest pain present a significant diagnostic challenge. With the introduction of some of the techniques discussed above, including EKG synchronization and high-pitch acquisition modes, the development of a single CT exam that could simultaneously evaluate the aorta, the pulmonary arteries (for PE), and the coronary arteries is an appealing goal. Rogg et al. found that patients who underwent workup for one of these conditions were more likely to receive simultaneous testing for one of the others [55], suggesting that a single test to evaluate for all through would be useful. Special considerations for the TRO CTA include the amount and timing of contrast administration, to ensure adequate opacification of both the aorta and coronary arteries, as well as the pulmonary arteries [56].

While this examination is now readily feasible and safe with modern CT scanners [57], its routine use in undifferentiated chest pain remains somewhat controversial, as the TRO CTA requires more contrast than standard CT angiography and use of EKG synchronization (with increased radiation dose) [58]. In a large meta-analysis of 11 studies with 3539 patients, Ayaram et al. found that while image quality was excellent for detecting coronary artery disease, the low prevalence of PE and dissection in these patients was not enough to recommend routine usage [59]. Similarly, in a very large review of 12,834 patients who underwent TRO CTA, Burris et al. found a slightly higher yield of PE and aortic disease, but at the expense of image quality, radiation dose, and contrast dose [60]. They too concluded that, while it certainly has value in individual cases, "its indiscriminate use is not warranted" [60]. A retrospective study of 2068 patients by Madder et al. found that TRO CTA resulted in higher radiation dose, but was not associated with improved diagnostic yield, reduced clinical events, or diminished downstream resource use, compared to conventional coronary CTA [61]. A retrospective study by Al Qahtani et al. of 467 patients presenting with atypical chest pain found the prevalence of acute coronary syndrome (ACS) and AAS was limited (0.5–5.5%) in those patients clinically suspected of having a pulmonary embolism, but the prevalence of ACS and PE was much higher (18% and 5.6%, respectively) among suspected AAS patients [62]. Finally, in the prospective, randomized CAPTURE trial of 59 patients, the authors concluded that, while helpful in certain circumstances, the TRO CTA "should not be used routinely with the expectation that it will improve efficiency or reduce resource use" [63].

Imaging Case Studies

Case 1

In Fig. 14.1, a 57-year-old man presents to the emergency department with "crushing" chest pain.

Fig. 14.1 57-year-old man presenting to the emergency department with "crushing" chest pain. Axial contrast-enhanced CT angiogram demonstrates an acute Type A aortic dissection. The false lumen (*) often has slower flow and will enhance less than the true lumen. The true lumen is typically smaller and more central in location. A fenestration or intimal tear is seen (*black arrow*), with communication between the true and false lumens

Case 2

In Fig. 14.2a, b, a 94-year-old man presents to the emergency department with chest pain.

Case 3

A 60-year-old man presents in Fig. 14.3a–d with a known history of penetrating atherosclerotic ulcer, arriving as an outpatient for presurgical planning.

Case 4

In Fig. 14.4a–d, a 63-year-old male with uncontrolled hypertension presents for a noncontrast CT thorax for preoperative planning prior to a CABG procedure.

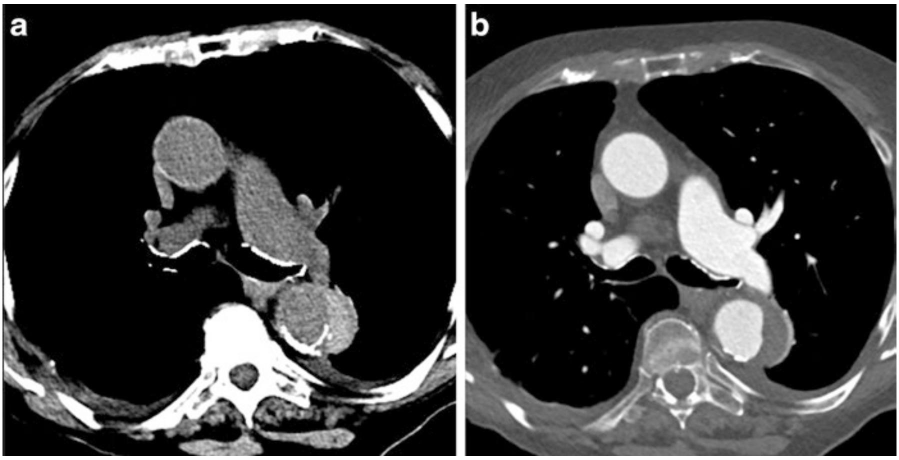

Fig. 14.2 94-year-old man presenting to the emergency department with chest pain. Precontrast images (**a**) are useful for demonstrating crescentic high attenuation along the wall of the descending aorta, consistent with Type B acute IMH. On post-contrast CT angiogram images (**b**), this region appears relatively low in attenuation compared to the adjacent contrast-enhanced aortic lumen and could potentially be misinterpreted as low attenuation (chronic) atherosclerotic plaque, rather than acute blood in the wall of the aorta

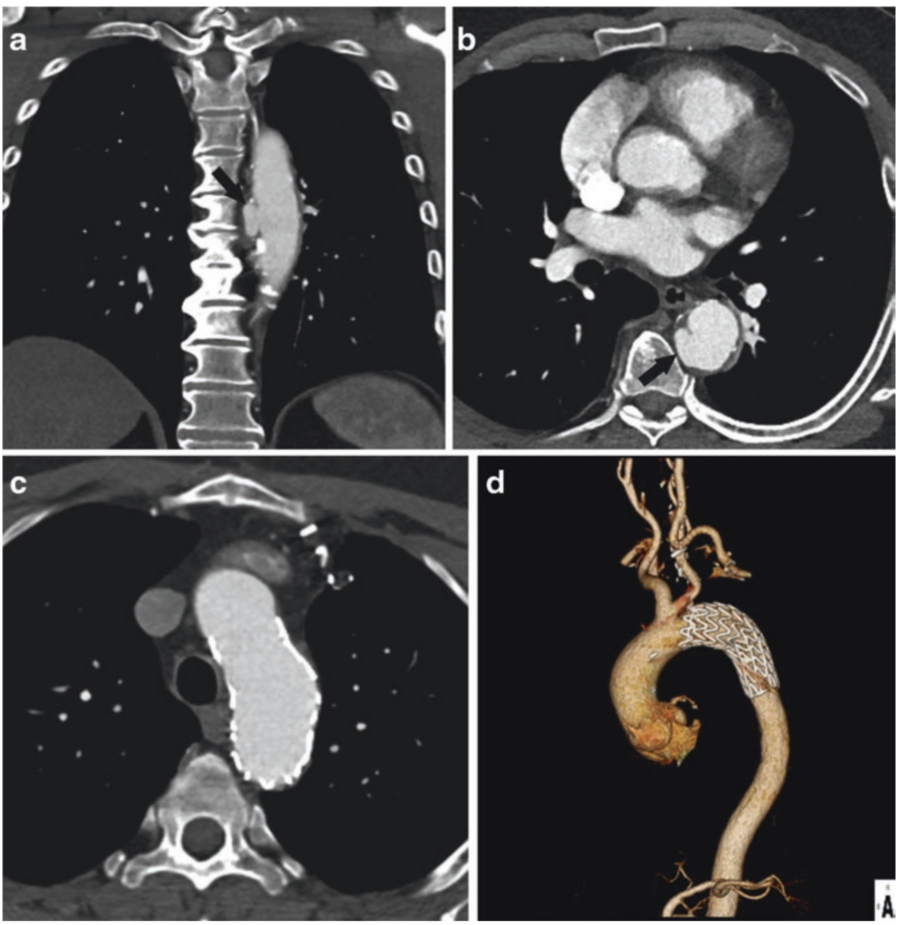

Fig. 14.3 60-year-old man with a known history of penetrating atherosclerotic ulcer, presenting as an outpatient for presurgical planning. Coronal (**a**) and axial (**b**) CT angiogram demonstrates a focal penetrating atherosclerotic ulcer (*black arrow*) in the mid-descending thoracic aorta. The patient underwent successful thoracic endovascular aortic repair (TEVAR), with resolution of the PAU (**c**, **d**)

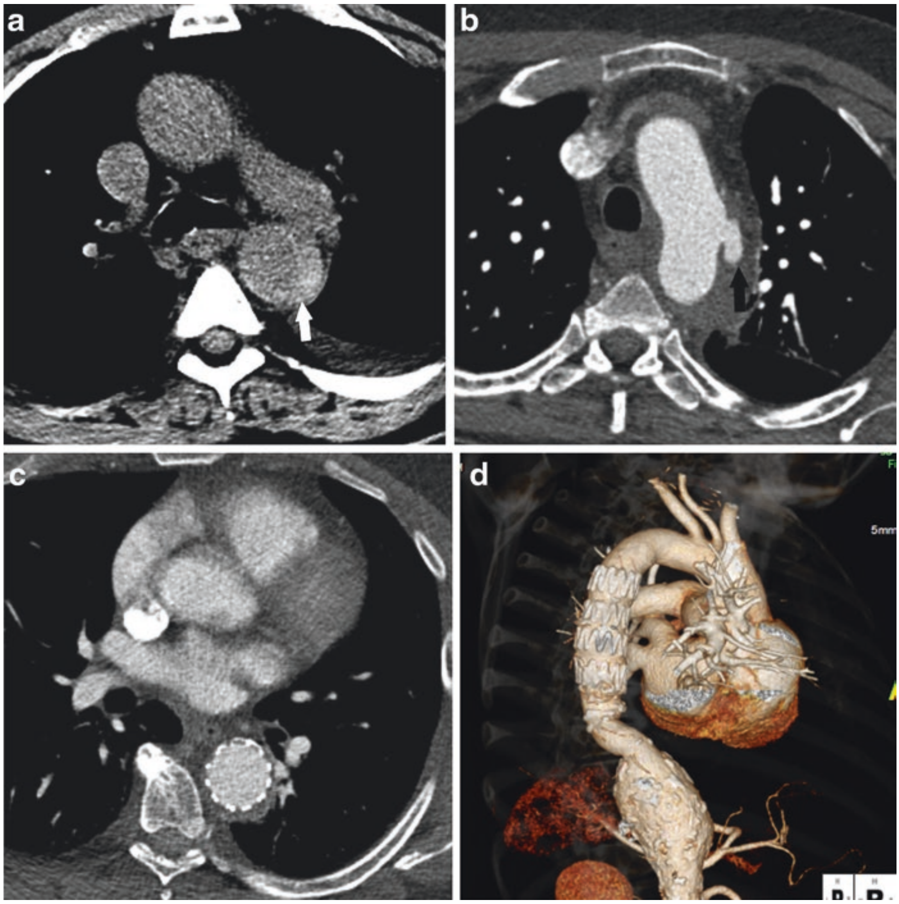

Fig. 14.4 63-year-old male with uncontrolled hypertension, presenting for a noncontrast CT thorax for preoperative planning prior to a CABG procedure. Noncontrast image (**a**) demonstrates crescentic high attenuation in the wall of the descending aorta (*white arrow*), consistent with acute IMH. Subsequently performed CT angiogram (**b**) in region of the distal aortic arch demonstrates a PAU as the cause of the IMH (*black arrow*). The patient underwent successful TEVAR, with resolution of the PAU (**c**, **d**)

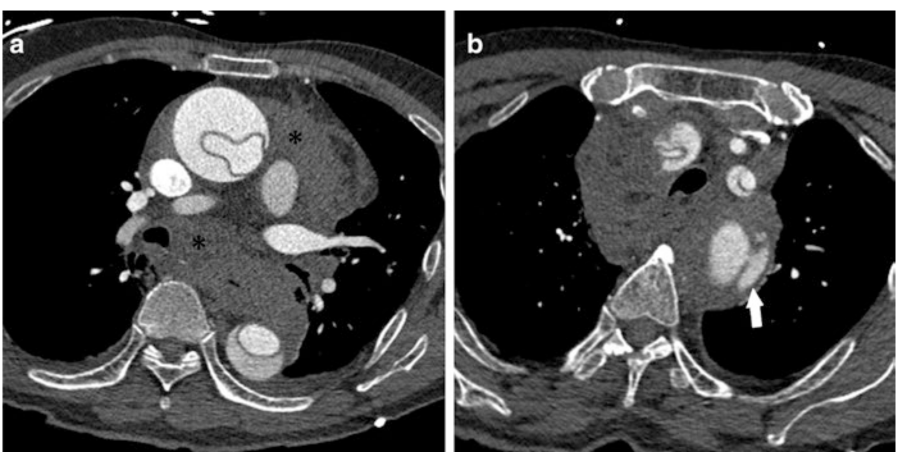

Fig. 14.5 81-year-old male presented to the emergency department with sudden onset of chest pain and was hypotensive. CT angiogram (**a**) demonstrates an acute Type A dissection involving the ascending and descending aorta, with a large amount of blood (hematoma) in the mediastinum (*). There is active extravasation from proximal descending aorta (**b**, *white arrow*). Findings consistent with aortic rupture

Case 5

An 81-year-old male presents in Fig. 14.5a, b to the emergency department with sudden onset of chest pain and was hypotensive.

Suggested Imaging Protocols

Chest radiography:

- Indicated for all patients presenting with suspected acute aortic syndrome
- Primary use is to exclude other etiologies that may mimic symptoms of AAS
- Normal chest radiographs do not exclude AAS and should not delay cross-sectional imaging in patients with symptoms of AAS

CTA Chest:

- Indicated for all patients presenting with suspected acute aortic syndrome
- Noncontrast images can be obtained to assess for acute intramural hematoma
- CT angiogram of the chest performed
- Consider EKG synchronization and/or high-pitch mode to reduce motion artifact in the ascending aorta and aid in assessing the coronary artery origins

MRI/MRA Chest:

- Indicated when patient is hemodynamically stable and able to cooperate
  - MRA with contrast of the thoracic and abdominal aorta
- If gadolinium contrast is contraindicated (renal failure, allergy)
- Noncontrast 3D SSFP respiratory-gated navigator sequences

Transesophageal echocardiography indicated as a viable alternative to CTA or MRA when an experienced operator is available to perform/interpret the images.

Future Research

- Role of dual-energy CT angiography in the setting of suspected acute aortic syndrome, and specifically the role of virtual noncontrast (VNC) images to detect acute intramural hematoma.
- Continued advancements in CT technology will allow faster gantry rotation times and higher pitch, to reduce/eliminate cardiac pulsation artifact without the need for EKG gating.
- Continued study of the role of the "triple-rule-out" exam in patients presenting to the emergency department with undifferentiated chest pain.

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