Acute aortic syndromes and aortic emergencies

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Abstract: Acute aortic syndrome (AAS) and emergencies are relatively uncommon but are considered as life threatening, potentially fatal conditions. Different forms of aortic emergencies/AAS are often clinically indiscernible. Prompt and accurate diagnosis of these entities significantly influences prognosis and guides therapy. We aim to elucidate the pertinent role that radiology plays in the management of acute aortic diseases, with contrast-enhanced computed tomography angiography (CTA) being the most rapid and robust imaging technique.

Keywords: Acute aortic syndrome (AAS); aortic rupture; aortic aneurysm; aortic emergencies; aortic dissection (AD)

Introduction

The term acute aortic syndrome (AAS) encompasses three pathological entities; aortic dissection (AD; 85–95% of AAS), penetrating aortic ulcer (PAU; 2–7%) and intramural hematoma (IMH; 0–25%) (1). Even though other conditions that represent aortic emergencies like trauma, iatrogenic/septic pseudoaneurysms, and ruptured atherosclerotic aneurysm have similar signs and symptoms, the term AAS is typically reserved for the aforementioned triad of AD, PAU and IMH entities. These conditions have a common clinical presentation and are typically associated with acute chest or back pain (2). These conditions are relatively uncommon (AAS incidence of 3.5 to 6.0 per 100,000 patient/years); but carry a high mortality rate (80–90% for aortic trauma and 50–60% for type A AD) (3-5). Rapid, accurate recognition and classification of AAS and aortic emergencies is, therefore, necessary (1,6). Treatment often entails a multidisciplinary approach involving medical, endovascular and surgical interventions. Imaging plays a key role in timely diagnosis and treatment planning.

Terminology and current understanding of AAS and aortic emergencies

AAS/aortic emergencies are often described by a large number of terms (*Figures 1,2*) that include traumatic and non-traumatic conditions. It is important to understand the terminology since they indicate different distinct pathological and survival implications.

AAS

The underlying etiology of AAS is most often an atherosclerotic disease. However, it can also result from other conditions such as medial degeneration, trauma or infection. Disruption of media layer of the aortic wall is a common feature of AD, IMH, PAU. AD results from splitting of the aortic wall layers by the blood entering through an entrance tear. An intimal flap separates the true lumen (TL), which is continuous with the nondissected aortic segment (unless the whole aorta is dissected), from the false lumen (FL). IMH was initially considered as bleeding within the media secondary to rupture of vasa-vasorum, but
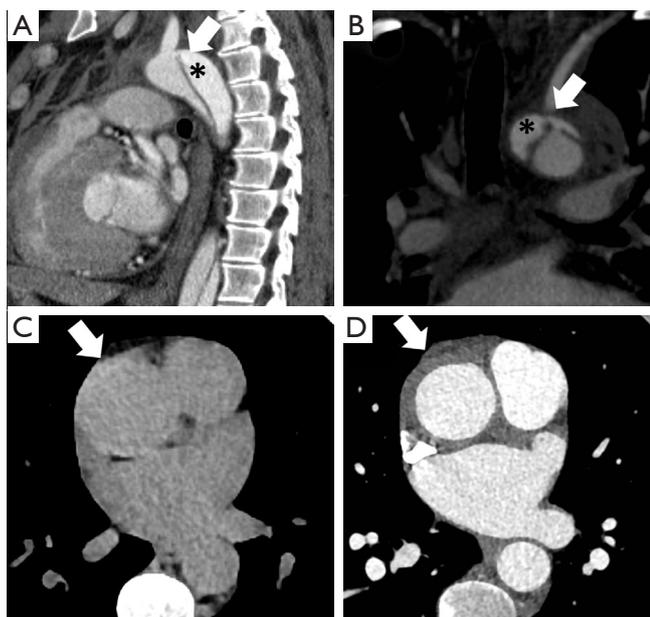
Figure 1 Terminology of AAS. (A,B) AAS starts with a tear in intima (arrows), when it leads to dissection of vascular media and distal reentry tears, the FL remains patent (asterisk) and is termed as classic dissection; (C,D) in absence of reentry tears, the dissecting blood may undergo complete thrombosis and form an intramural hematoma (arrows). AAS, acute aortic syndrome; FL, true lumen.

this theory has not been thoroughly validated (7). Increasing number of investigations have demonstrated the presence of micro tears, early in the disease course of IMH, by imaging and in pathological specimens (7-10). These findings suggest a common pathophysiologic mechanism between AD and IMH, with the only difference between the two is the presence of a re-entrance tear large enough to maintain the patency of a FL in the AD (*Figure 3*) (7-9,11). PAU refers to an atherosclerotic plaque that corrodes through the internal elastic lamina into the media to variable depths. It may further spread through the media to form a typical IMH or through the adventitia to form a pseudoaneurysm (12).

Besides the classic triad, some authors also include limited or focal dissection within the umbrella of AAS. A limited dissection indicates an intimomedial tear without intramural separation (12).

Intimal tear

It refers to focal discontinuity in the internal elastic lamina of the blood vessel that forms the gateway to let blood to spread through the vascular media. Often, these tears are
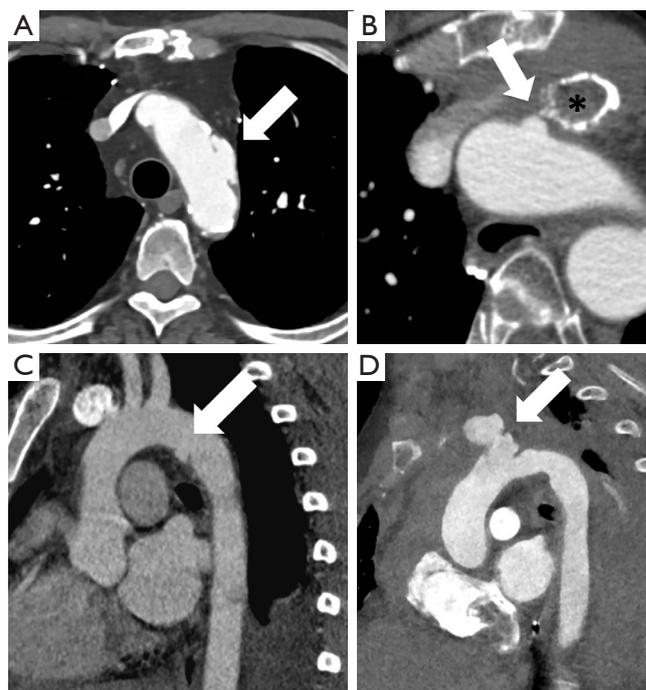

Figure 2 An intimal tear can remain localized and form a penetrating ulcer (A; arrow). Pseudo-aneurysm refers to a blood-filled sac arising from the vascular wall and lacks a tri-layer wall (B; arrow). It shows a contrast filled outpouching arising from the anterior aspect of aortic arch as a result of traumatic injury (displaced clavicle; asterisk). Focal dissection refers to an intimomedial tear without intramural separation (C; arrow). Aortic transection refers to trans-mural discontinuity of the aortic wall and is generally associated with a hematoma which can be contained (D; arrow) in the mediastinum or freely communicate with body cavities such as pleural or pericardial spaces.

the index events in AAS.

Aortic pseudoaneurysms

This is a blood-filled outpouching that arises from a vessel and does not contain all three layers of the vessel wall (intima, media, and adventitia). It occurs as a consequence of full thickness vessel wall injury or tear. Pseudoaneurysms can form secondary to atherosclerosis, trauma, infection and iatrogenic insult such as aortic cannulation or inadvertent aortic puncture.

Aortic trauma

Total of 75–80% of thoracic aortic injuries are attributed

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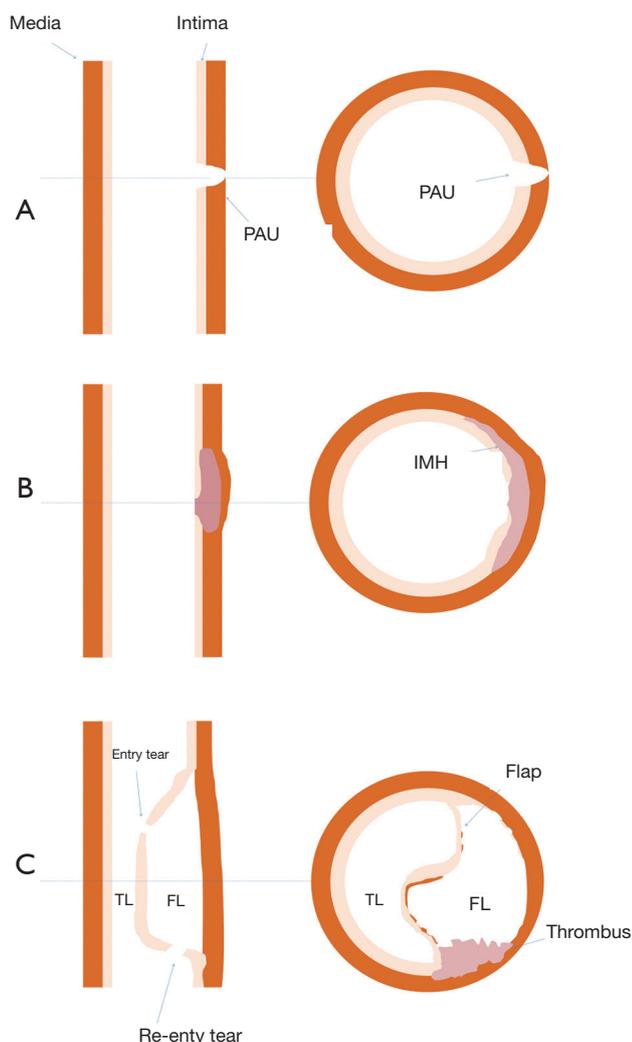**Baliyan et al. Pictorial review of AAS and emergencies**

Figure 3 Illustrative demonstration of different types of AAS. Disruption of media layer of the aortic wall is a common feature to AD, IMH, PAU. (A) PAU is an ulcerated plaque that has extended into the vascular media. There is a common pathophysiologic mechanism between IMH (B) and AD (C). AD results from splitting of the layers of aortic wall with an entrance tear. An intimal flap separates the TL, which is continuous with the non-dissected aortic segment, from the FL. The only difference between the two being the presence of a re-entrance tear large enough to maintain the patency of a FL in AD. FL can have variable degree of thrombus depending on the flow dynamics. AAS, acute aortic syndrome; TL, true lumen; AD, aortic dissection; IMH, intramural hematoma; PAU, penetrating aortic ulcer; FL, true lumen.

to a rapid deceleration in the setting of high-speed motor vehicle collisions. Aortic root and isthmus are the most vulnerable sites for these injuries since they are the tether points where a relatively mobile aortic arch connects with relatively fixed structures, heart, and descending aorta respectively. The aorta may also be injured directly as a result of penetrating thoracic trauma.

Aortic injuries result in rapid exsanguinations and in most cases fatal before medical attention can be sought. Studies suggest that only 20% patients with an acute traumatic aortic injury initially survive for more than one hour (6,13,14). Nevertheless, a significant number of aortic injuries make their way to the hospital and require prompt diagnosis and management, as if left undetected and untreated they result in rapid in-hospital mortality (30% within the first 6 hours, 49% within the first 24 hours) (10).

Aortic trauma may manifest as limited or classic dissection, IMH, pseudoaneurysms or aortic transection. Aortic transection refers to a full thickness tear of the aortic wall with loss of continuity at the transected ends. This disruption leads to the development of a surrounding hematoma which, depending on its extent, can either remain contained within the mediastinal fat or freely communicate with the pericardial or pleural cavities.

Ruptured aortic aneurysm

Aortic aneurysms most commonly occur as a consequence of atherosclerotic disease. It results from weakening of the diseased aortic wall that is also at an increased risk of rupture. Aneurysms can have an emergent presentation in the following settings; impending rupture, small contained leaks with subtle infiltration of adjacent fat or overt extravasation into the body cavity (*Figure 4*) (15).

Retrograde type A dissection

Retrograde type A dissection comprises of 7–25% of acute type A dissections which differ from a typical type A dissection with a primary tear in the aorta beyond the left subclavian and the FL propagates in a direction opposite to the direction of blood flow, i.e., towards the proximal arch and ascending aorta. While most acute type A dissections have a tear in the aortic root or ascending aorta with an antegrade propagation of the FL (16,17). This tends to
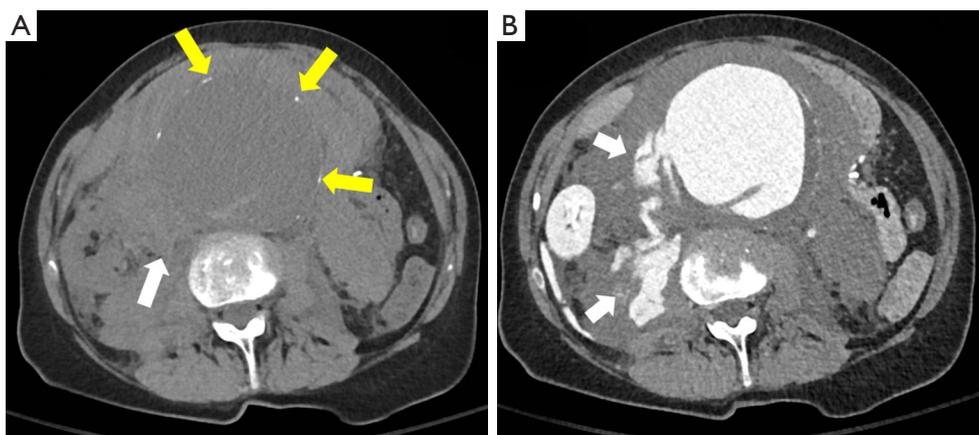
Figure 4 Axial non-contrast CT image (A) demonstrates a large abdominal aortic aneurysm with calcifications along the intima (yellow arrows) and indistinct surrounding fat planes (white arrow). Arterial phase image (B) shows a focal discontinuity in the aortic wall with frank extravasation of intravenous contrast into the retroperitoneum (arrows).

occur in type B dissections when the primary tear is in close proximity to the aortic arch and decompression of FL, through the distal aortic branches, is less effective (17). Compared with antegrade type A, the aortic root is less commonly involved in retrograde type A dissections, and successful aortic valve resuspension is often possible (17).

Prognostication and, triage in AAS and aortic emergencies

Stanford classification is the most widely used prognostic classification for AAS. Although primarily used for ADs, it can be also applied in IMH (12). It divides dissections depending upon segments of aortic involvement. Type A affects ascending aorta and arch and may result in occlusion of coronary vessels, incompetence of aortic valve or rupture into the pericardial space. Type A AAS (AD, IMH, and PAU) and aortic emergencies carry a high risk of mortality with conservative management and are treated with emergent surgical intervention (1,5,18-20). Type B abnormalities commence distal to the origin of the left subclavian artery and uncomplicated type B ADs can be managed by a more conservative approach with medication and/or EVAR, due to a significantly higher mortality after open repair (1,4,21,22). Complicated type B dissections with organ or limb malperfusion, progressive dissection, intractable pain, or uncontrolled hypertension are managed by a more invasive approach, preferably EVAR (5). The goal of EVAR in AD is to seal the entry tear in order to decompress the FL. Fenestration is another treatment option in situations where

the TL gets compressed by a high-pressured FL resulting in visceral hypoperfusion, and EVAR stent-graft placement is not feasible. This includes cases with large aortic diameter, a critical vessel close to entry tear or unfavorable anatomy with inadequate seal. Fenestration procedure is performed to create a hole in the dissection flap, which allows outflow from the FL. It decompresses the FL, reduces the risk of dissection flap advancement, and relieves the obstruction of branch vessels. Fenestration procedure may also be combined with stent-graft placement (23). Other indications for an invasive approach in type B include, IMH with enlargement of aortic diameter, development of an ulcer-like projection, or progression of IMH into frank dissection (12). EVAR may also be the treatment of choice in aortic trauma that involves the junction of an arch and the descending thoracic aorta (24).

Imaging of AAS/aortic emergencies

Usually the first imaging modality performed is a chest radiograph. A supine chest radiograph is frequently obtained in the setting of acute trauma to identify life-threatening conditions such as massive hemothorax or tension pneumothorax. It also provides an opportunity to detect unsuspected aortic trauma. A chest radiograph is also frequently obtained in patients who present with chest pain. Contrast-enhanced computed tomography angiography (CTA) is indicated when the radiograph is positive or equivocal in the setting of a high clinical suspicion. CTA is an excellent tool for triaging AAS into surgical and non-
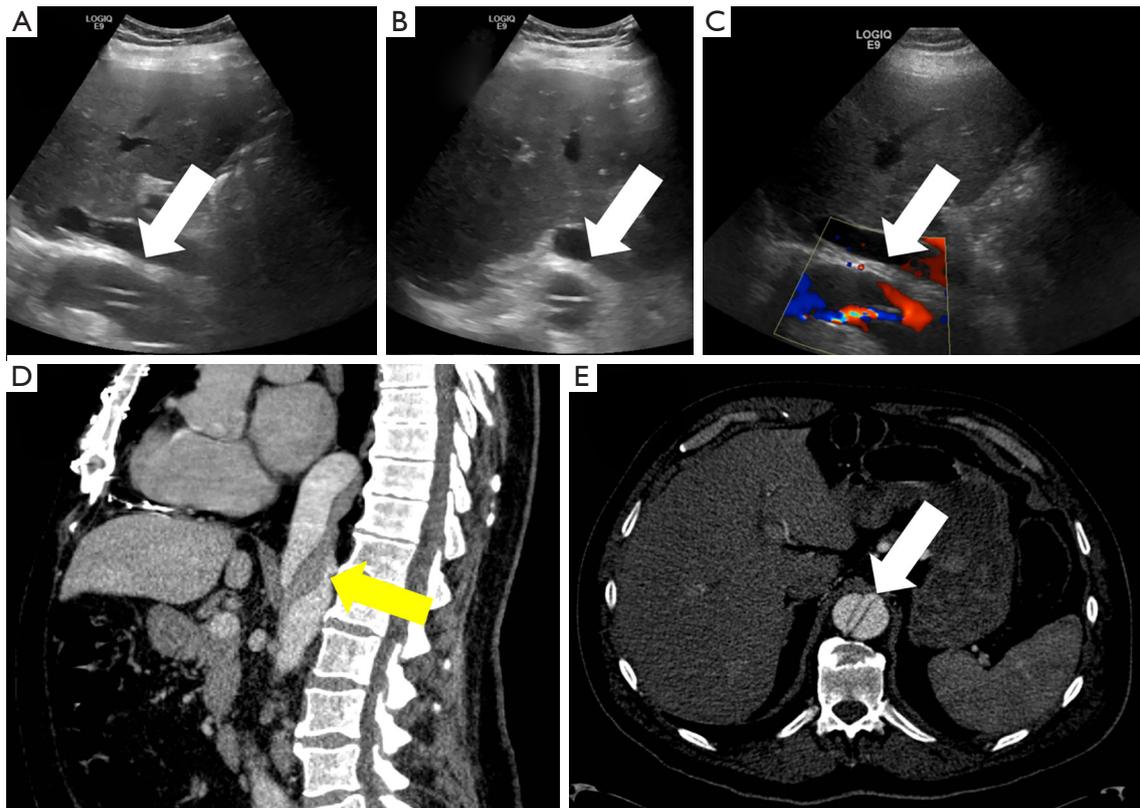
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Figure 5 Detection of abdominal aortic aneurysm and dissection by ultrasound. Ultrasound images (A,B,C) in oblique sagittal planes demonstrate a dissection flap within the proximal abdominal aorta (arrows) that was confirmed on follow-up CTA (sagittal, D; arrow) and (axial, E; arrow). CTA, computed tomography angiography.

surgical management strategies. It can also reliably identify clinically significant aortic injury and ruptured aortic aneurysms in stable patients (24). Since it is rapid, non-invasive, widely available, and provides high quality three-dimensional images, CTA is the diagnostic modality of choice for aortic emergencies and AAS. Transesophageal echocardiography (TEE) and abdominal ultrasound are bedside tools that may enable identification of AAS and aortic emergencies for clinically unstable patients in intensive care units (25). However, TEE requires an experienced operator, sedation, and endotracheal intubation and provides only a limited view of the aortic arch, distal ascending aorta and abdominal aorta. Abdominal aortic aneurysms and dissections may occasionally be detected on abdominal ultrasound examination (*Figure 5*) in lean patients. However, it is not the imaging modality of choice in diagnosis or long-term follow up for these conditions (25). Magnetic resonance angiography (MRA) can be used as an alternative to CTA in select cases when ionizing radiation

or allergic reactions to iodinated intravenous contrast agents are to be avoided (26). Non-contrast MRA can also be performed in patients with renal dysfunction (26). The strengths and weaknesses of different imaging modalities have been summarized in *Table 1*. Since CTA is the work-horse for the imaging in aortic emergencies/AAS and MRA is the most commonly used alternative imaging the next section is focused on these two modalities.

CTA

CTA is excellent in defining vascular anatomy and classifying AAS into Stanford types (*Figure 6*), which is the key to management (27). Variations in anatomy such as retroesophageal anomalous arch vessels, coarctation, right-sided arch and vascular rings can also be recognized.

CTA protocol-A typical triple phase CTA protocol is similar to routine aortic angiography and described in detail in the article on non-invasive aortic imaging in the same

Table 1 Imaging modalities used for evaluation of acute aortic syndromes and emergencies

Modality	Strengths	Weaknesses	Practical use
Radiography	Frequently obtained "first-line" exam, quick, low radiation exposure	Low sensitivity and specificity; poor for evaluating of extent	Most useful in trauma
CTA	Quick to perform; excellent for definition of anatomy, extent and classification into Stanford types, detection of complications, predictors of progression and end organ ischemia	Radiation exposure, iodinated contrast material use. Not available bedside	Most widely used modality for most patients with suspected AAS/aortic emergencies
Echocardiography	Availability at bedside and intra operatively; functional information	Operator dependent, requires sedation and endotracheal intubation; limited view for aortic arch, distal ascending aorta and abdominal aorta	Can be useful for quick bedside/ intra operative assessment of unstable patients
MRA	Good for definition of anatomy, extent and classification into Stanford types; useful for detection of complications, and end organ ischemia	Long scan times, not available round the clock in most institutions; requires higher level of patient co-operation than CTA	An alternative of CTA in select patients with iodinated contrast allergy, renal dysfunction and to avoid ionizing radiation

CTA, computed tomography angiography; AAS, acute aortic syndrome; MRA, magnetic resonance angiography.

issue. It is important to re-emphasize that a non-contrast phase is essential in patients with suspected AAS because IMH and wall calcifications are apparent on this phase (*Figure 7*). Cardiac motion can result in artifacts which may mimic or obscure dissection flaps in the proximal ascending aorta. Motion also obscures the anatomical details of the aortic root (21,22). To overcome these limitations aortic CTA is performed with ECG-gated protocols which minimize pulsation artifacts and dramatically improve visualization of the aortic root and ascending aorta (28,29). Examination of the thoracic aorta should always include the evaluation of abdominal aorta and iliac arteries, because of the high risk of involvement of these vessels and also to facilitate endovascular treatment planning, if needed. Delayed phase is acquired 1 to 2 minutes after injection to assess late filling of contrast in the FL (*Figure 8*), contrast extravasation in aortic rupture and end organ hypoperfusion (*Figure 9*) (30-35). It is also often required for evaluation of associated abdominal vascular and visceral injuries in trauma (30-35). A cerebrovascular accident in a setting of AD carries a poor prognosis (25), therefore CT and CTA of the head must be acquired in cases with suggestive symptoms or if the innominate or left carotid artery is involved.

CTA protocols performed with dual-energy CT (DECT) technique provide additional benefits in vascular imaging. While a standard triple-phase CTA entails acquisition of a true non-contrast (TNC) phase, virtual-unenhanced images can be created from a DECT, thus enabling streamlined protocols with considerably reduced radiation exposure (*Figure 10*) (36). Furthermore, availability of different virtual monochromatic and material-density image reconstructions can be exploited to assess the vascular and parenchymal enhancement or to mitigate artifacts secondary to metal hardware. These patients may have compromised hemodynamic status, the improved contrast-to-noise ratio of low keV images can also be exploited to reduce the amount of contrast media administered (37,38).

In addition to assessing for AAS, CT also enables in establishing an alternate diagnosis or depicts other incidental findings. Incidental findings are routinely detected (up to 89%) during CTA and when significant must be communicated in the report (39).

MRA

The urgency of diagnosis AAS, limited availability of MRA during afterhours and the high average scan time limits its use as the diagnostic modality of choice. Contrast-enhanced MRA can be a useful alternative to CTA in selected patients with iodinated contrast allergy and when ionizing radiation has to be avoided (26). Non-contrast MRA can also be performed in patients with renal failure where use of intravenous contrast media is contraindicated (26).

Rapid black blood sequences provide a natural contrast between the lumen and the vessel wall layers. A standard
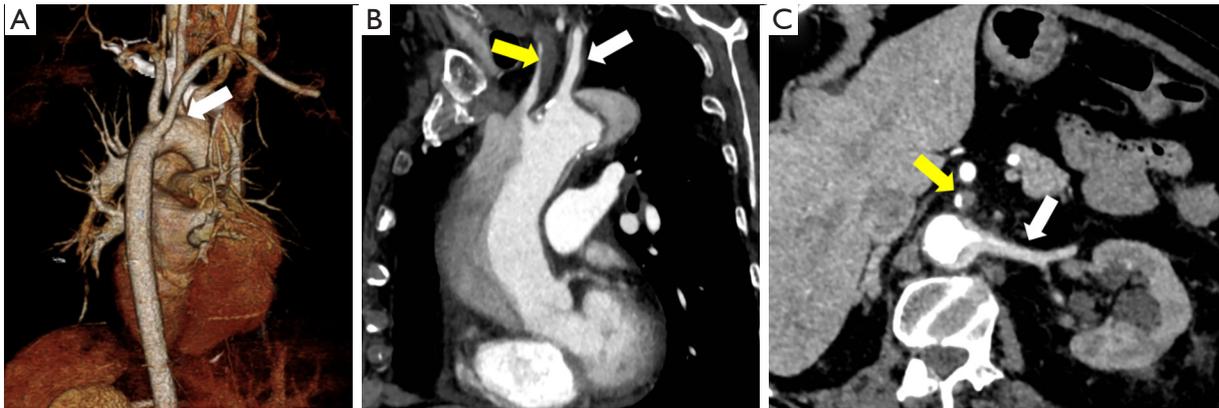
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Figure 6 CTA is an excellent modality for delineating vascular anatomy and can depict normal variants or dissection flap extensions with sub-millimeter resolution. Volume rendered CT image (A) shows an aberrant right subclavian artery (arrow). Coronal oblique CTA image from a different patient (B) demonstrates a type A dissection starting from the aortic root and extending into the left common carotid (yellow arrow) and subclavian arteries (white arrow). It further (C) extends into the superior mesenteric artery (yellow arrow) causing moderate vascular stenosis. The left renal artery is arising from the FL (white arrow) causing hypoenhancing left kidney. CTA, computed tomography angiography; FL, true lumen.
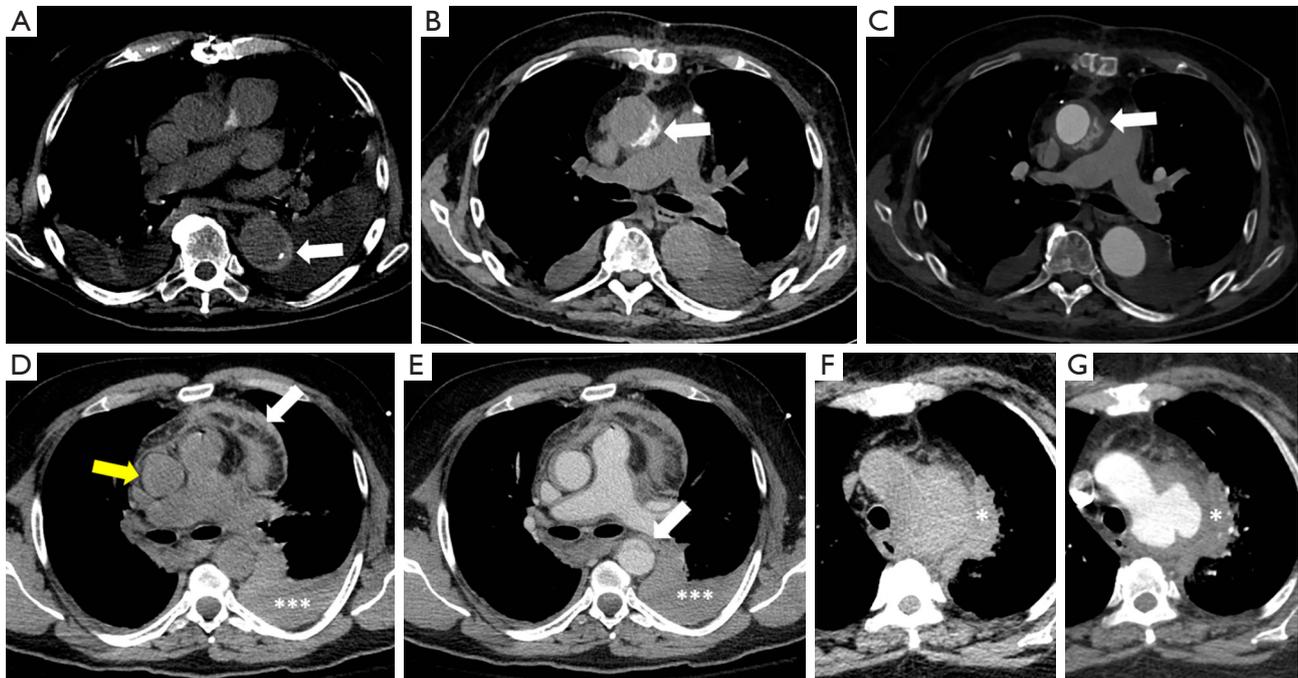

Figure 7 Utility of acquiring non-contrast CT for all patients with suspected AAS. It is valuable in detecting acute intramural hematomas that appear as crescentic hyperdensity with inward displacement of the medial calcification, when present (A; arrow). It is also helpful in discriminating hyper dense structures such as calcifications and surgical graft material (B,C; arrows) from contrast extravasation. On an arterial phase (C) alone, it can be mistaken as hyperdensity due to active contrast leak. Hyperdense acute intramural hematoma (D,E; yellow arrow), hemopericardium (D; white arrow), hemothorax (D,E; asterisks) and mediastinal hematoma (F,G; asterisk) also appear conspicuous on non-contrast images. AAS, acute aortic syndrome.
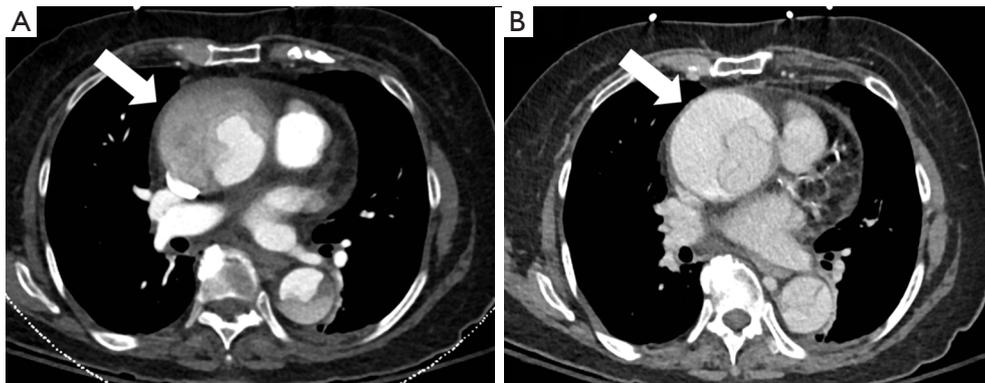
Figure 8 Delayed phase CT images are helpful in differentiating thrombus from slow flow. Axial arterial phase CTA image (A) shows hypo-enhancement within the FL (arrow), which shows homogeneous enhancement on delayed phase (B) suggesting slow flow hemodynamics (arrow). CTA, computed tomography angiography; FL, true lumen.
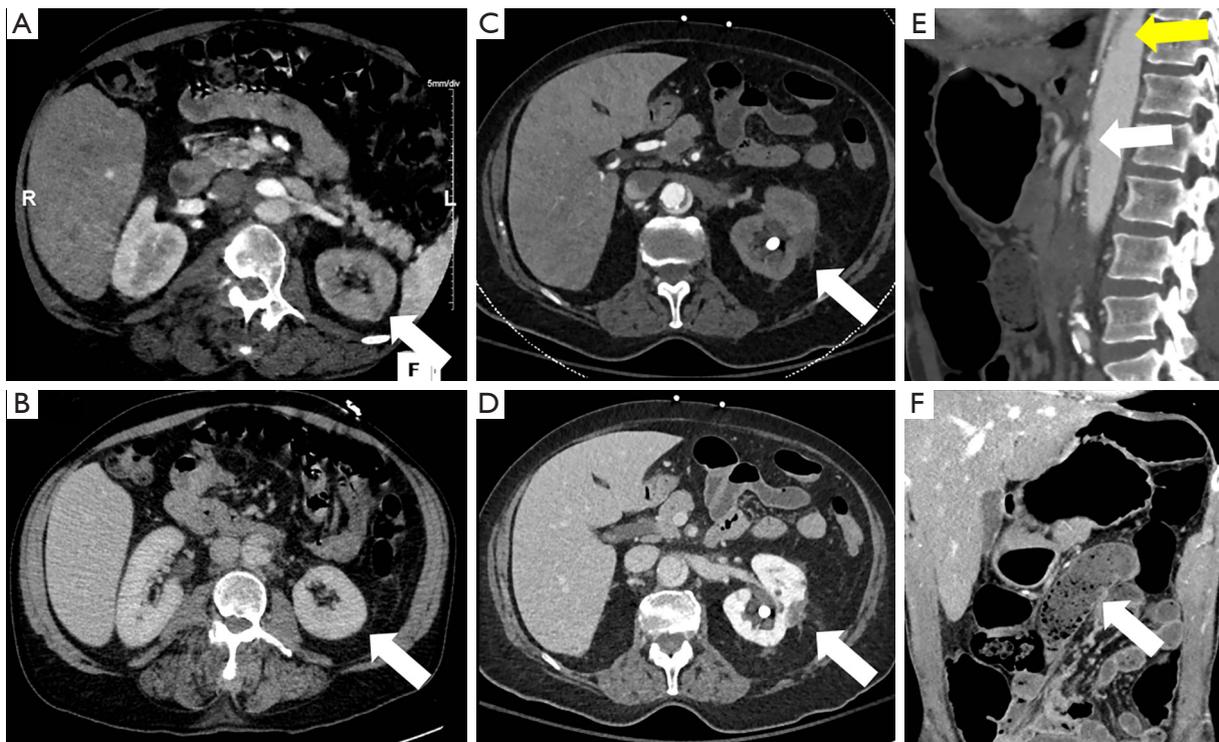

Figure 9 Delayed phase CT images are helpful in assessing end-organ perfusion. Axial arterial phase image (A) shows extension of dissection flap into the left renal artery with left renal parenchymal enhancement (arrow). The left kidney shows homogenous enhancement on delayed phase (B; arrow) similar to the right kidney indicating delayed perfusion. A few areas in the hypoperfused kidneys on arterial image (C; arrow) fail to enhance on delayed phase (D; arrow) suggestive of focal renal infarcts. Sagittal CTA image (E) demonstrates a severely compromised true lumen (yellow arrow) with compression and narrowing at SMA ostium (white arrow). Coronal venous phase image shows a dilated jejunal loop with hypoenhancing walls (F; arrow), suggestive of bowel ischemia. CTA, computed tomography angiography; FL, true lumen.
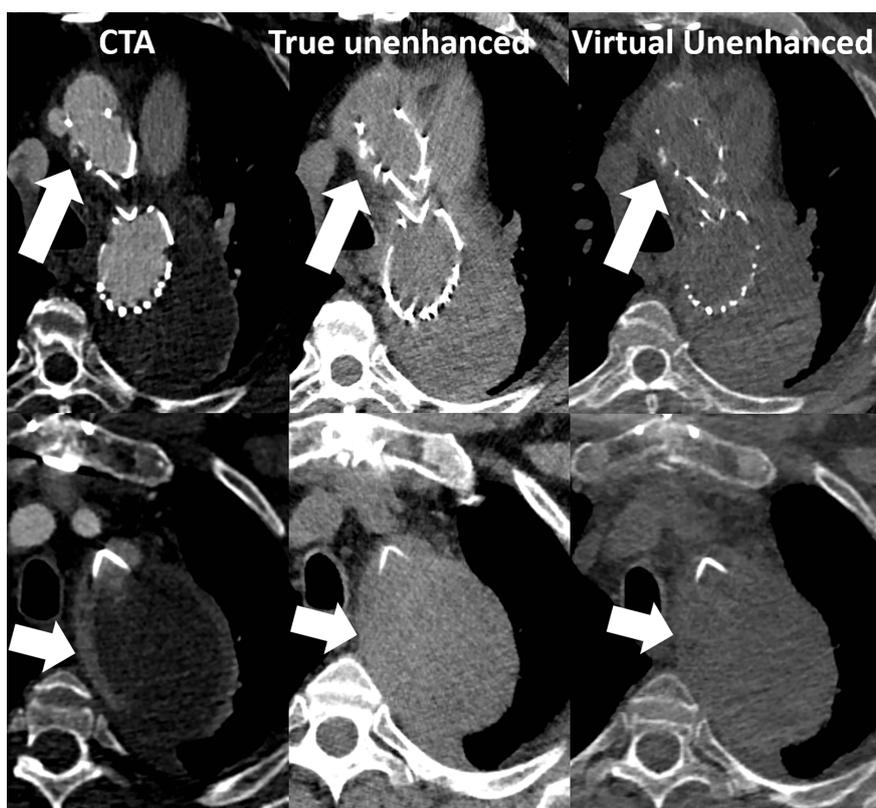
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Figure 10 DECT angiography in a patient with endograft repair and type III endoleak. There is a small focus of hyper density in relation to the proximal landing zone, which could be mistaken for a type Ia endoleak/extravasation. The TNC images are helpful in differentiating the hyper density from contrast vs. calcification/graft material (top panel, arrows). The VNC and reconstruction images accurately identify the hyperdensity as non-iodine containing. VNC are also comparable to TNC in characterizing the hyper density in the FL as iodinated contrast (bottom panel, arrows). DECT, dual-energy computed tomography; TNC, true non-contrast; VNC, virtual non-contrast.

MRA should begin with T1W and T2W black blood sequences covering the entire aorta (40). A non-ECG gated fluoroscopically triggered gadolinium (0.2 mmol/kg of body weight) enhanced MRA can be acquired over a period of few minutes in severely ill patients within a matter of seconds (although setting up the exam takes much longer time and additional sequences are required for full interpretation). An ECG tracing can be acquired with the imaging data, which can be reconstructed in the different phases of the cardiac cycle and displayed in cine mode. Non-contrast MRA with balanced steady-state free precession techniques are increasingly applied in patients at risk for renal insufficiency or nephrogenic systemic fibrosis (25,41).

As the protocols for MR are evolving and acquisitions with shorter scan times are being explored, the use of MR in the emergency department is increasing (26). A recent study demonstrated that majority of MRIs performed in

the emergency department do not increase the length-of-stay (42). This has implications on the existing workflow and reassessment of utilization of MR in this setting for different indications, especially vascular emergencies.

Imaging signs for AAS/aortic emergencies

AAS

As discussed in the definition section AAS probably start with a breach in the intima. Intimal tears are well defined in AD but may be difficult to visualize in IMH and PAU.

PAU

On CTA and MRA a penetrating ulcer is often seen as an irregular ulcerated plaque with contrast agent outpouching extending beyond the aortic intima with variable degree of associated IMH.
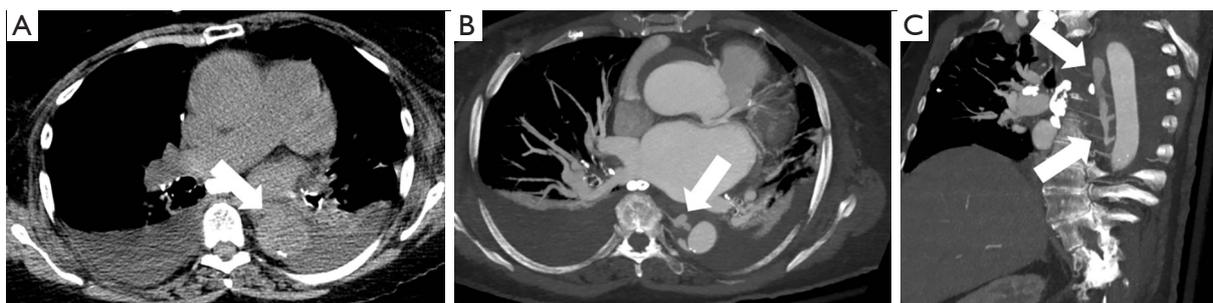
Figure 11 Axial non-contrast CT (A) shows a hyperdense crescentic IMH with displacement of medial calcification (arrow). There is intramural blood pool within the hematoma communicating with the intercostal arteries and aortic lumen (B,C; arrows). Ulcer-like out pouching and intramural blood pool suggest high risk for progression and its presence should be informed to physicians. IMH, intramural hematoma.

IMH

The IMH is identified as a crescentic thickening of the aortic wall containing clotted blood products. These blood products are hyperdense on CT and are associated with inward displacement of the aortic intima. Intimal calcification may help in defining the vessel intima (43). Both of these findings can be appreciated on non-contrast CT images. IMH may also appear hyperintense on T1W black-blood images on MRA. Imaging findings that prognosticate IMH include Stanford type, IMH thickness, maximal aortic diameter, and presence of ulcer-like projections on adventitial aspect and intramural blood pools. The intramural blood pool in the IMH is classically described as Chinese ring sword sign (*Figure 11*) (44).

AD

The hallmark of the AD is a flap that divides the aorta into true and FL. Radiographs may rarely show displacement of intimomedial calcification at the aortic knuckle with AAS or AD; and often may be negative or show non-specific secondary signs such as pleural effusion. The important clinical information in AD can be classified under following headings.

Site of injury

CTA is highly accurate in depicting site of intimal tear and Stanford type classification and branch vessel involvement.

Extent of involvement

Relationship of the origins of branch vessels relative to true versus FL is particularly important for surgical planning. The degree of involvement of arch vessels may influence the surgical approach and prognosis in type A dissection and should be addressed while assessing aortic CTA (25). Extension into the aortic root (dysfunction of the aortic valve), and coronaries must also be looked for in type A dissection. Left-sided branches of the abdominal aorta (most often the left renal artery) are at a higher risk of involvement compared to the right side (25). AD may influence the flow through a branch vessel in a number of ways. Branch can originate from a FL with limited flow or thrombosis, vessel can arise from upstream obstructed TL, a flap can cause by dynamic obstruction of flow prolapse into the ostium or fixed obstruction by stopping at or extending into the vessel (25,29). The signs of these mechanisms must be looked for on CTA. Contrast enhanced MRA has similar sensitivity for detection of AD flap, anatomical classification and branch vessel involvement. Additionally, gradient-echo sequences or phase contrast images can be acquired in stable patients for identifying entry or re-entry sites, aortic insufficiency and differentiating slow flow from thrombus in the FL of patients with AD (45-47).

TEE can identify dissection flaps, localize the intimal tear, detect IMH, and atherosclerotic PAU in sick patients in ICU setting (48). It performs better for the intimal flap in the proximal ascending aorta and a short segment of the descending aorta but often limited in evaluation of the arch and distal descending aorta (25). TEE is useful in identifying aortic valve dysfunction, pericardial tamponade, or wall motion abnormalities. It may also add additional value in depicting the occurrence and mechanism of aortic regurgitation secondary to AD. Aortic regurgitation manifests when the dissection flap extends into the sinus of
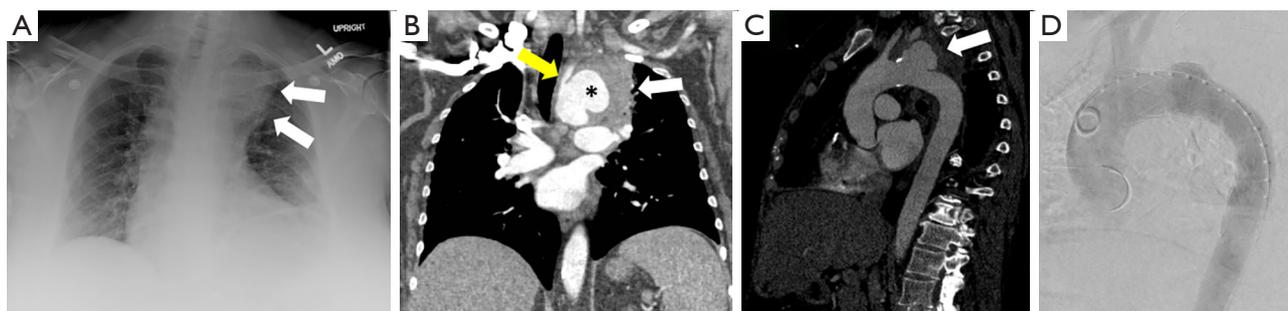
Figure 12 Radiograph of a 60-year-old female with a history of diabetes mellitus and hypertension and recent onset chest pain. Radiograph reveals mediastinal widening (A; arrows) and CTA reveals large aortic pseudoaneurysm (B; asterisk) distal to the origin of the left subclavian artery (B,C; arrows). Patient underwent an endovascular repair (D). CTA, computed tomography angiography.

Valsalva or prolapse through the aortic orifice. Identification of mechanism helps in determining the mode of surgical correction and may facilitate root sparing repair (49). It is also useful in determining the origins of the coronary ostia in relation to dissection flap, extension of flap into the coronary, ventricular function, pericardial effusion and tamponade (25).

Secondary complications

Pericardial or pleural effusion, in association with dissection, should raise the suspicion of rupture into the pericardial or pleural space. Pericardial fluid with an attenuation of over 40 Hounsfield units (HU) on non-contrast scan should be considered as hemopericardium (50). Involvement of visceral vasculature is a risk factor for mortality and is better evaluated by performing venous or delayed phases as part of CTA (51). CT also depicts findings of altered visceral perfusion that occur as consequence of aortic emergencies. Since left branch vessels are most commonly involved, the left kidney carries the greatest risk of visceral ischemia. On imaging, this is visualized as areas of relative hypoenhancement as compared to remainder ipsilateral or contralateral kidney. Involvement of bilateral intercostal arteries may result in spinal medullary infarct. In approximately one quarter of patients, AD is associated with lower limb ischemia (25).

Aortic trauma

Aortic injury may range from intimal injury alone (minimal aortic injury) to aortic transection with active extravasation (*Figure 2*). The aortic isthmus is the most common site of insult (52). These injuries often occur along the medial curvature of the distal arch close to the left pulmonary

artery and left main stem bronchus. Mediastinal widening greater than 8 cm or 25% of the width of the thorax is the most frequent and sensitive radiographic finding for mediastinal hematoma (*Figure 12*) (6,53,54). Presence of contour abnormality of the transverse aortic arch, loss of aortopulmonary window and obscuration of the interface between the lung and transverse or descending thoracic aorta also raise concern for significant aortic trauma. Secondary signs, like depression of left main stem bronchus, rightward deviation of tracheal or nasogastric tubes, left apical cap, fractures of the first and second ribs, hemothorax and pneumothorax, may also indicate the presence of an aortic injury (6). It should be borne in mind that up to 7% of aortic trauma cases have normal chest radiographs (53). Therefore, a high index of suspicion such as in patients with a history of rapid deceleration injury warrants further evaluation despite a normal radiograph. Furthermore, these findings can also be seen in conditions such as goiter, mediastinal masses leading to false positive outcomes. Therefore, when aortic trauma is suspected on a radiograph in stable patients, it should always be evaluated further by CTA (55). In unstable patients, an emergent thoracotomy may be indicated.

A soft-tissue-attenuation mass with areas of high attenuation (>60 HU), associated with loss of periaortic fat planes on CTA should raise a high suspicion for aortic trauma. Other findings include a sudden change in the aortic caliber, abnormal aortic contour, intimal flap, pseudoaneurysm and intraluminal mural thrombus (6). Multiple autopsy series have reported ascending aorta and root as the second most common location for aortic trauma (56). However, infliction at this location is rarely seen on CTA, presumably due to high risk of pre-hospital demise (57). Injuries to the aortic arch and branch vessels
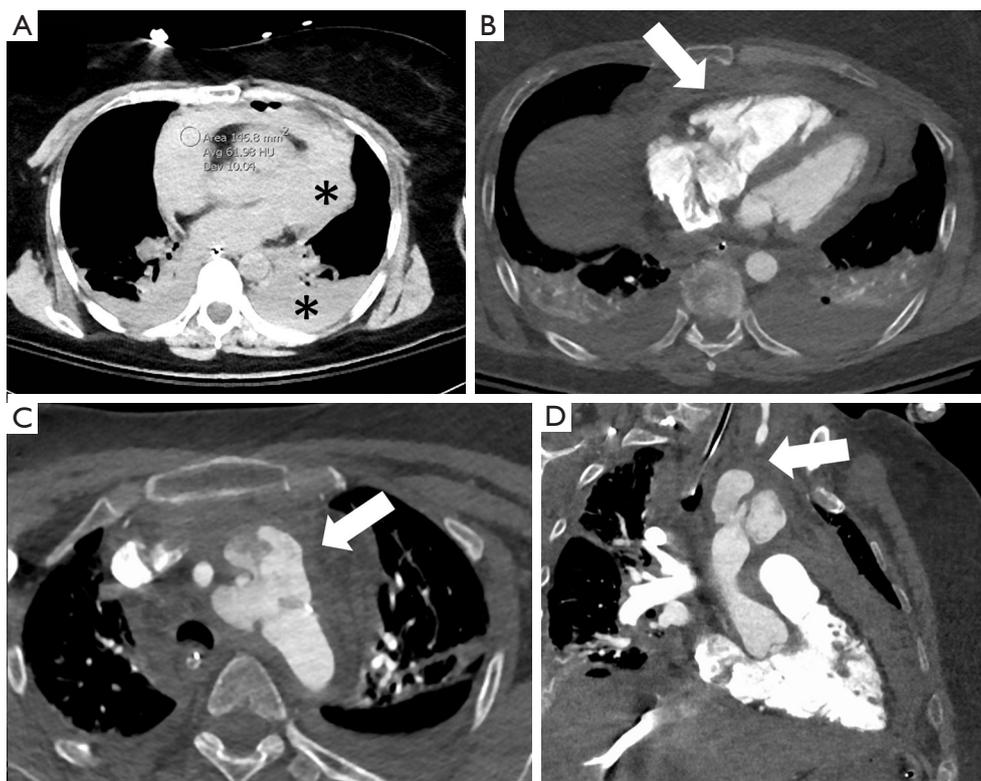
Figure 13 CT in a victim of high-velocity motor vehicle trauma demonstrates high density mediastinal hematoma with high density pleural and pericardial effusions (A; asterisks). Axial CTA image (B) reveals a dilated right ventricle that appears larger than left ventricle due to left-ward displacement of the interventricular septum suggestive of tamponade (arrow). There was a transected aortic arch (C,D) with surrounding contained pseudoaneurysm/hematoma (C; arrow), which was compressing the proximal left common carotid artery (D; arrow). CTA, computed tomography angiography.

are less common but potentially fatal (*Figure 13*).

Normal post-isthmic aortic dilatation or aortic spindle and ductus remnants are a normal finding in the isthmic region and should not be misinterpreted as an aortic injury. Collapsed lung adjacent to the aorta should also not be mistaken as intimal flap or IMH.

Aortic aneurysm rupture

Active contrast extravasation from an aortic aneurysm is diagnostic of aneurysmal rupture (*Figure 4*). It is generally associated with a variable degree of mediastinal or retroperitoneal hematoma. Contrast material extravasation into the involved portion of the bowel, intraluminal and periaortic extraluminal gas are rare signs of abdominal aortic rupture fistulizing with the bowel (15). The enlarging maximum diameter is the most reliable and established predictive sign of impending aneurysmal rupture, but it requires prior baseline comparison, which might not be

available many instances. The additional imaging signs of impending aortic rupture include periaortic fat stranding, draping aorta sign, focal discontinuity in circumferential wall calcifications and hyperdense peripheral crescent within the mural thrombus (15). The draping aorta sign is considered present when the posterior wall of the aortic aneurysm drapes or moulds to the anterior surface of the vertebra. Usually, the fat planes between the aneurysm and vertebra are lost (15).

Conclusions

AAS/aortic emergencies are life threatening conditions that warrant prompt management. It is important to be familiar with the terminology used in the description of AAS/aortic emergencies and their respective implications. Radiology plays a highly valuable role in the management AAS and aortic emergencies. Radiographs are easily obtainable and

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often the first imaging modality performed. CTA is the most widely used imaging technique. It is quick to perform, provides an excellent definition of anatomy and extent, and detects complications, predictors of progression and end organ ischemia. In select patients with allergy to iodinated contrast or renal dysfunction, MRA can be performed as an alternate to CTA.

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Footnote

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