

# Abdominal aortic aneurysm: pictorial review of common appearances and complications

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**Abstract:** Abdominal aortic aneurysms (AAAs) are defined as focal dilatations of the abdominal aorta that are 50% greater than the proximal normal segment or when it is more than 3 cm in maximum diameter. The early diagnosis and treatment is very important to prevent catastrophic complications. Due to its ability to assess the peri-aortic soft tissue and the exact extension of aneurysm, as well as its excellent vascular opacification and multiplanar reconstruction capabilities, computed tomography angiography (CTA) has become an integral part of the evaluation of AAA and has virtually replaced conventional angiography for the evaluation of AAA. Knowledge of the characteristic imaging features of AAA is essential for the prompt diagnosis of life-threatening complications. In this pictorial essay, we will discuss the CTA findings in AAA and its complications including rupture, infection, aorto-enteric fistula and aorto-caval fistula.

**Keywords:** Aortic aneurysm; complications; CT; aorto-enteric; aorto-caval fistula

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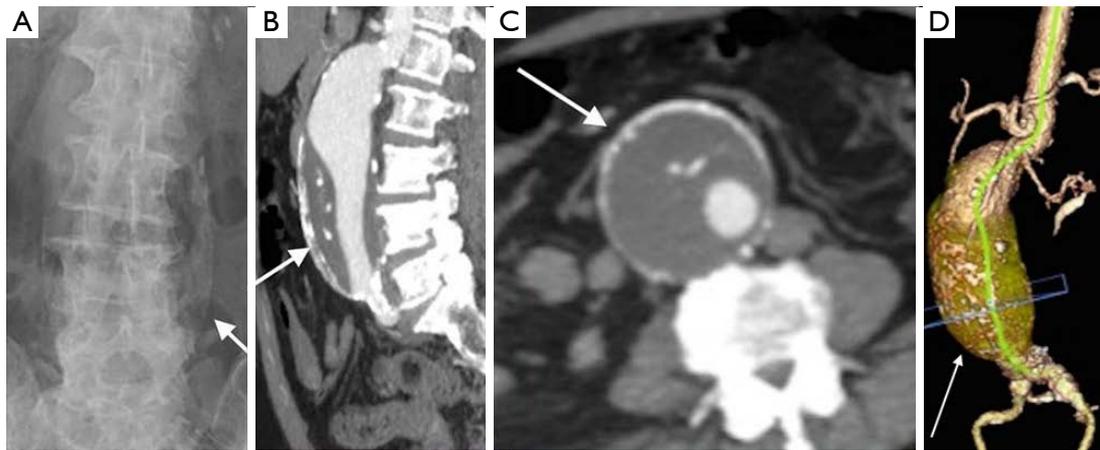
## Introduction

Abdominal aortic aneurysms (AAA) are defined as abnormal dilatation of the abdominal aorta up to more than 3 cm in the greatest diameter or dilatation of more than 50% of its diameter. It remains a leading cause of death in the United States, nearing just less than 5,000 deaths due to the most dreaded complication, rupture (1). The risk factors include male gender, age >75 years, prior vascular disease, hypertension, cigarette smoking, family history, hypercholesterolemia (2). The most common location includes infrarenal with extension into iliac arteries. Atherosclerosis is the most common causative factor. Inflammatory abdominal aortic aneurysm, vasculitis such as Takayasu arteritis, connective tissue disorders such as Marfan syndrome and Ehlers-Danlos syndrome, mycotic aneurysm, traumatic pseudoaneurysm, anastomotic

pseudoaneurysm are other notable causes. Treatment options include conservative follow up for aneurysms less than 5 cm to surgical open repair with graft placement as well as endovascular repair using stent graft placement. Overall, AAA accounts for approximately 45,000 operations in United States each year (1).

## Clinical presentation

Most AAAs are asymptomatic and often incidentally detected. Unruptured aneurysms may uncommonly cause abdominal or back pain, or a pulsatile mass, if large. Ruptured aneurysms present with severe abdominal or back pain, hypotension and shock. Ruptured aneurysms are associated with high mortality (59–83% of patients succumb to death before they make it to hospital or undergo surgery).



**Figure 1** Plain film of a lumbar spine in a patient with lower back pain (A) demonstrates a large calcified aortic aneurysm (arrow). Follow up CTA and 3D images (B,C,D) demonstrate a large partially thrombosed infrarenal aortic aneurysm (arrow). CTA, computed tomography angiography.

### Role of imaging

Imaging is essential for the detection of AAA, monitoring of rate of growth, pre-operative planning and post-operative follow-up. Although abdominal radiographs may show curvilinear calcification in the paravertebral region (*Figure 1A*), it is not optimal for detection or follow-up. Ultrasound is simple, safe and inexpensive with sensitivity of 95% and specificity close to 100%. It is the preferred modality of choice for monitoring of small aneurysms, especially in thin subjects.

CTA is the gold standard and imaging modality of choice (3,4), but has high radiation doses. It has an excellent value for pre-operative planning including the evaluation of aortic size, rostral-caudal extent, presence of intraluminal thrombus, involvement of visceral arteries, extension into the suprarenal aorta (*Figure 1B-D*). It is superior to US in detecting and sizing common iliac artery aneurysms. MR angiography can provide the same information as CTA, but can be costlier, and less widely available and has longer imaging times. But this is especially useful in young patients due to lack of ionizing radiations and in situations where intravenous contrast is contraindicated, such as allergic reactions to intravenous contrast and renal failure (5). Role of digital subtraction angiography (DSA) is limited in the diagnosis of AAA due to advent of CTA. DSA also does not show true aneurysm size if there is mural thrombus. DSA is still an important tool in the endovascular treatment of the AAA (6).

### Complications

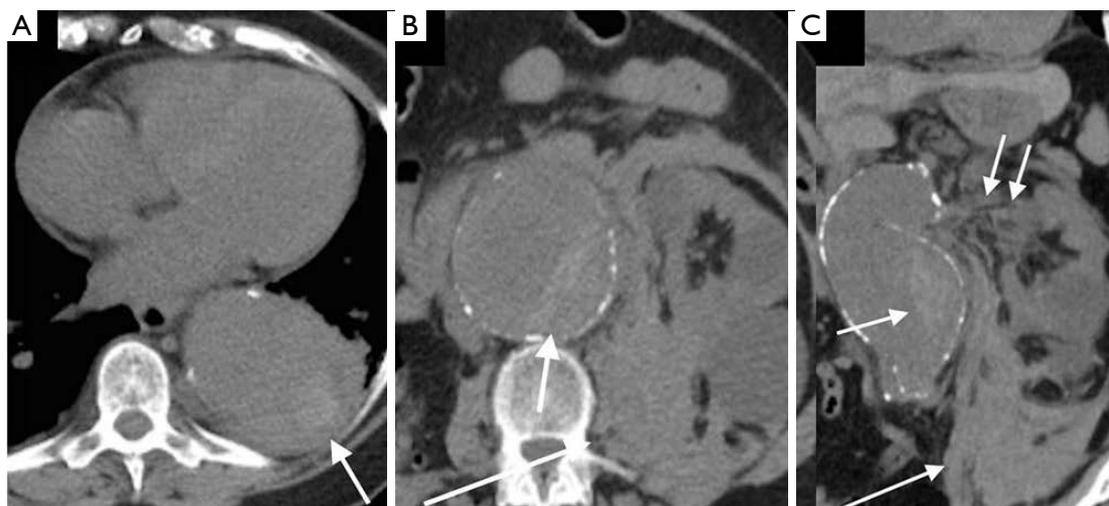
The complications of AAA include rupture, infection, aorto-enteric fistula, aorto-caval fistulas pseudoaneurysm, thrombotic occlusion of branch vessel and compression of adjacent structures.

#### Rupture

Acute rupture of AAA is a surgical emergency, and if left untreated, it has a mortality rate approaching 100%. The rupture most commonly involves the posterolateral aspect of the aortic wall, which results in hemorrhage into the retroperitoneal spaces including the perirenal space, pararenal spaces, and psoas muscles. Thus, the most common imaging feature of aneurysmal rupture is the presence of a retroperitoneal hematoma adjacent to AAA and peri-aortic stranding (*Figure 2*). Extravasation of IV contrast (*Figure 3*) reflects active bleeding (4). Secondary signs of rupture include high attenuation crescent (*Figure 2*), hematoma within either the mural thrombus or the aneurysmal wall, focal discontinuity of intimal calcification (*Figure 2*), tangential calcium sign, intimal calcification pointing away from the aneurysm, draped aorta sign, indistinct posterior aortic wall, posterior aorta following the contour of the spine on one or both sides (7).

#### Contained rupture

The diagnostic criteria for contained rupture include



**Figure 2** Non-contrast axial (A,B) and coronal (C) CT images of the abdomen demonstrate descending thoracic and abdominal aortic aneurysms with rupture: note the large retroperitoneal hematoma (larger arrow), and periaortic stranding (double arrows). The patient also has a high attenuation crescent sign (smaller arrow)—a secondary sign of rupture.



**Figure 3** Axial CTA image demonstrates the presence of high attenuation contrast (larger arrow) in the retroperitoneal hematoma (smaller arrow) suggestive of active bleeding in a ruptured aortic aneurysm. CTA, computed tomography angiography.

known abdominal aortic aneurysm, previous pain symptoms that may have resolved, stable hemodynamic status with a normal hematocrit. CT imaging with show retroperitoneal hemorrhage, no evidence of active extravasation (*Figure 4*), with draping aorta sign (8).

### ***Infected (mycotic) aneurysms***

Mycotic aneurysms account for 0.7–2.6% of aortic

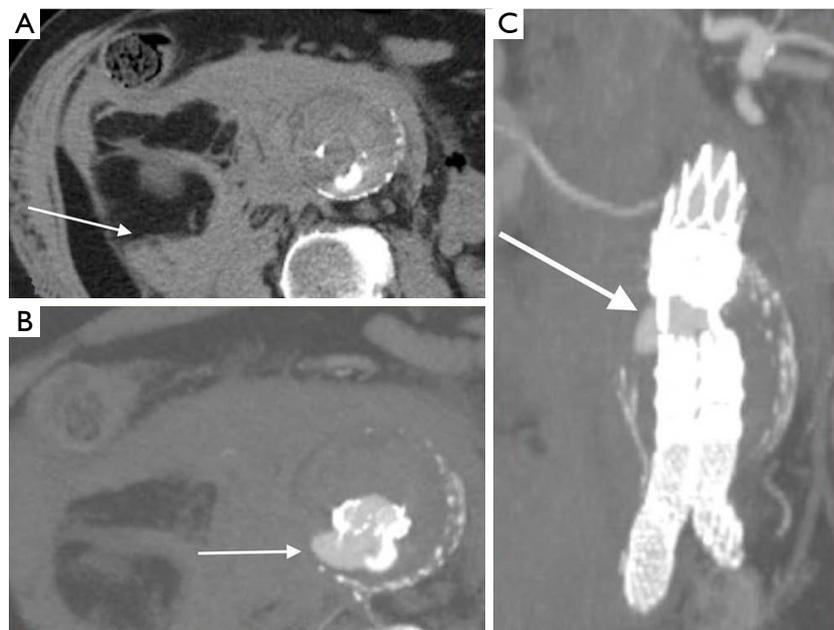
aneurysms. They are very prone to rupture, with rupture rate of 53–75% at surgical repair. They can be caused by hematogenous seeding from septicemia or direct spread from vertebral osteomyelitis, renal and psoas abscesses (9). The majority are located in thoracic or suprarenal abdominal aorta. CT angiography will show saccular shape as opposed to fusiform shape in atherosclerotic aneurysms, lobular contours, and periaortic inflammation, abscess, and mass (*Figure 5*). They have rapid expansion rate than that of atherosclerotic aneurysms (10,11).

### ***Aortoenteric fistulas***

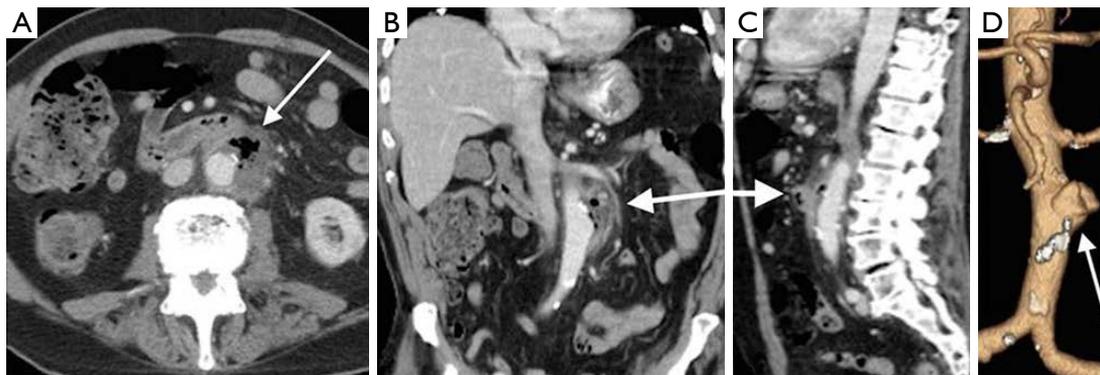
Aortoenteric fistulas can be primary, caused by atherosclerotic aortic aneurysm or secondary related to from aortic reconstructive surgery. Secondary aortoenteric fistulas are more common than primary fistulas. They usually occur between two weeks and eight years after surgery. The most commonly involved part of the gut 3<sup>rd</sup> & 4<sup>th</sup> portions the duodenum. Symptoms usually include abdominal pain, hematemesis, and melena. CT imaging will show rupture with gas within or outside the aneurysm sac. However, this finding can be seen in mycotic aneurysms as well. The contrast extravasation into the bowel (*Figure 6*) is diagnostic (12).

### ***Aorto-caval fistulas***

Aorto-caval fistula is a rare and devastating complication



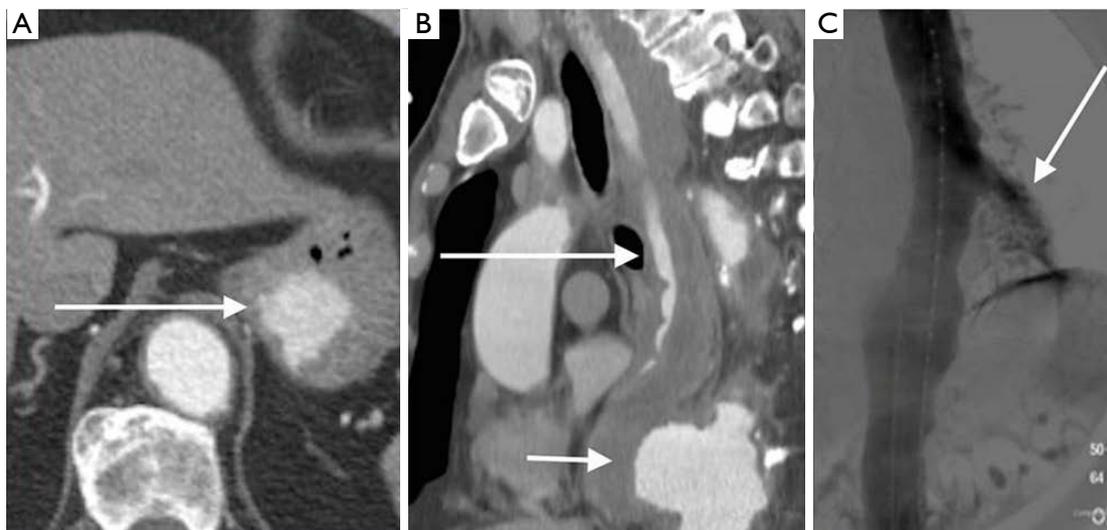
**Figure 4** Axial and coronal CTA images (A) of the abdomen in a patient with acute back pain demonstrate a contained rupture of AAA with periaortic retroperitoneal hematoma extending into the right side of the the retroperitoneum (arrow). The patient had prior repair of the AAA with an endovascular graft. Axial and coronal MIP images (B and C) demonstrate a type III endoleak (arrows) in the proximal aspect of the graft. CTA, computed tomography angiography; AAA, abdominal aortic aneurysm.



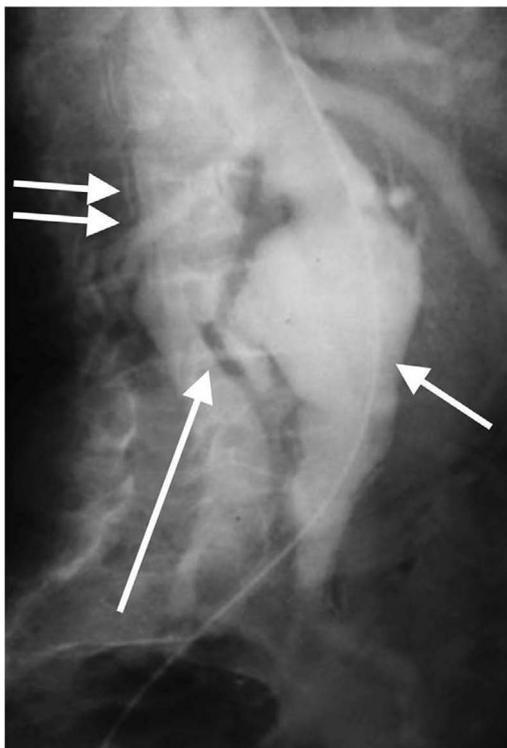
**Figure 5** Axial (A), coronal (B) and sagittal (C) images of the chest and abdomen from a CTA study in a patient with AAA demonstrate a saccular AAA with foci of air and hazy peri-aortic stranding (arrow) consistent with ruptured mycotic aneurysm. The 3D image (D) demonstrates the focal saccular aneurysm (arrow). CTA, computed tomography angiography; AAA, abdominal aortic aneurysm.

in which aneurysm erodes into the IVC. It accounts for <1% of all aneurysms and in ~3% of ruptured aortic aneurysms. The features can be very atypical leading to a delay in diagnosis. The clinical features include faintness, syncope, hypotension, high output cardiac failure, bilateral pedal edema, renal insufficiency

(reduced renal blood flow) and continuous bruit. Imaging studies will show opacification of the IVC in the arterial phase (*Figure 7*). These patients need urgent surgical exploration with 20–55% operative mortality. The increased mortality is predominantly due to misdiagnosis or delayed diagnosis (13).



**Figure 6** Axial (A) and sagittal (B) images from a CTA study in a patient with an acute chest pain demonstrate a saccular aneurysm in the descending thoracic aorta (smaller arrow) with rupture and fistulous communication into the distal esophagus. IV contrast is seen in the esophagus and fundus of stomach (longer arrow). A digital subtraction angiogram (C) demonstrates the fistulous communication (arrow) with contrast seen in the stomach. CTA, computed tomography angiography.



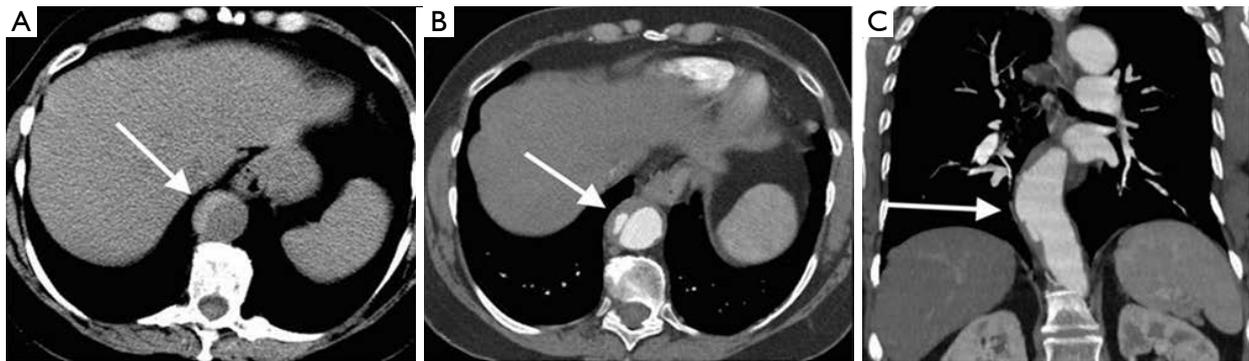
**Figure 7** Conventional catheter aortogram demonstrating a spontaneous aortocaval fistula (larger arrow) between AAA (smaller arrow) and the IVC (double arrow). AAA, abdominal aortic aneurysm.

### Pitfalls

On unenhanced CT, false lumen thrombus in aortic dissection and intramural hematoma of the abdominal aorta may mimic the hyperattenuating crescent sign, mimicking impending rupture in AAA (*Figure 8*). Furthermore, decreased attenuation of the patent lumen in patients with severe anemia due to low hematocrit level may also cause the arterial wall to appear hyperattenuated on unenhanced CT, thus simulating the hyperattenuating crescent sign. As a result, familiarity with such common pitfalls may be essential to improve diagnostic accuracy (14).

### Treatment and prognosis

The risk of AAA rupture is proportional to the size of the aneurysm and the rate of growth (15). Rupture of AAA usually have devastating consequences, thus necessitating regular follow-up and urgent treatment. The treatment is usually required when diameter of AAA >5.0 cm in women, >5.5 to 6.0 cm in men, expansion rate >10 mm/yr. for any size and symptomatic patients. Management options include endovascular aneurysm repair (EVAR) and Open surgical repair (16,17).



**Figure 8** Axial noncontrast CT image (A) of the thoracoabdominal aorta shows hyperdense intramural hematoma (arrow) which can mimic hyperdense crescentic sign of impending rupture of aneurysm. Axial (B) and coronal (B) CTA images shows penetrating aortic ulcer (arrow). CTA, computed tomography angiography.

## Conclusions

Most patients with AAA are asymptomatic and the diagnosis is made incidentally. Imaging findings of aortic aneurysm rupture vary along a spectrum from impending rupture to contained rupture and from small aortic leaks with subtle infiltration of retroperitoneal fat to frank retroperitoneal or intraperitoneal extravasation. Aortic aneurysms most commonly occur as a consequence of atherosclerotic disease of the aorta. Alternatively, they may be associated with infectious seeding of the native or surgically repaired vessel (17). Prompt detection of abdominal aortic aneurysm rupture is critical because survival is improved by emergent surgery. Identification of impending or contained rupture is equally important because these patients are at risk for frank rupture, but can generally benefit from a more thorough preoperative assessment, followed by urgent surgery.

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## Footnote

*Conflicts of Interest:* The authors have no conflicts of interest to declare.

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