The Acute Abdominal Aorta

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KEYWORDS

• Aorta • Aneurysm • Rupture • Penetrating atherosclerotic ulcer • Aortitis • Thrombosis • Aortoenteric fistula

KEY POINTS

- Acute disorders of the abdominal aorta are potentially lethal conditions that require prompt evaluation and treatment and are primarily imaged with computed tomography (CT). MR imaging may be useful in select applications.
- Common subcategories of the acute abdominal aortic syndrome include unstable or ruptured aneurysm, dissection, penetrating atherosclerotic ulcer, and intramural hematoma, each of which has characteristic imaging features and distinct prognosis and management.
- Aortic inflammation and infection are less common acute aortic conditions with imaging features that often are better shown on portal venous rather than arterial phase CT or MR imaging.
- Acute traumatic injury of the abdominal aorta is rare, but should be evaluated with attention to direct and indirect imaging signs that help vascular surgeons grade injury severity and decide between observation and urgent repair.
- Aortic fistulas most commonly involve the duodenum after open aortic repair. Diagnosis of aortoenteric fistula is based primarily on observation of indirect, often subtle, imaging findings rather than active contrast extravasation.

INTRODUCTION

Acute disorders of the abdominal aorta are potentially lethal conditions that require prompt evaluation and treatment. Common subcategories of the acute abdominal aortic syndrome include unstable or ruptured aneurysm, dissection, penetrating atherosclerotic ulcer, and intramural hematoma (IMH). Inflammation, infection, traumatic injury, fistulization, and occlusion of the abdominal aorta are rare conditions that nevertheless warrant high clinical suspicion because of the potential catastrophic consequences of misdiagnosis. The clinical diagnosis of these diseases often is elusive because symptoms may be nonspecific, including abdominal pain, back pain, or hypotension. Consequently, imaging plays a vital role in guiding patient management.

The workhorse imaging method for evaluating acute conditions of the abdominal aorta is computed tomography (CT) because of its availability and rapid image acquisition capability, which enable inclusion of the entire abdomen and pelvis, thus allowing for possible alternative diagnoses. In addition, modern CT equipment and software provide for radiation dose reduction and high-quality multiplanar reconstruction. MR imaging is a helpful alternative imaging method for stable patients who have a contraindication to iodinated contrast. Although ultrasonography is useful in screening

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for and monitoring abdominal aortic aneurysms, it generally is not used in the setting of suspected acute aortic conditions. Therefore this article focuses on the CT and MR imaging features of acute conditions of the abdominal aorta and how these studies guide management.

NORMAL ANATOMY

The abdominal aorta extends from the diaphragmatic hiatus at T12 to the iliac bifurcation, following the curvature of the lumbar spine. It traditionally is divided into suprarenal, juxtarenal, and infrarenal segments based on the relationship with the renal arteries. The aortic wall consists of 3 layers: the endothelium or intima; the media, composed of smooth muscle; and the adventitia, the outermost connective tissue layer that provides structural support for the vessel. Normal abdominal aortic luminal diameter is approximately 2 cm, measured perpendicular to the long axis of the lumen.

IMAGING TECHNIQUE AND PROTOCOLS

Computed Tomography

CT, the most commonly used imaging method for evaluating the abdominal aorta, enables scanning of the entire abdomen and pelvis in 5 to 10 seconds with excellent z-axis resolution. When an acute aortic condition is suspected clinically, it is advisable to begin the CT examination with a noncontrast acquisition, which improves identification of critical findings, such as an IMH or high-attenuating crescent sign. Although abdominal aortic aneurysm rupture or impending rupture may be diagnosed on the noncontrast images alone, postcontrast images usually are required in order to acquire preoperative aortic measurements for endoluminal stent graft repair. Oral contrast is contraindicated when evaluating the aorta, because it may obscure subtle findings, such as an aortoenteric fistula (AEF).[1]

The authors routinely acquire scans of the abdominal aorta in the arterial phase using a CT angiogram protocol, injecting 100 to 125 mL of iodinated contrast at a rate of 4 mL/s with bolus tracking over the descending thoracic aorta and a 15-second delay (**Table 1**). Images are obtained with 2-mm slice thickness and a reconstruction interval of 1 mm with a detector collimation varying from 0.6 to 1.2 mm depending on the scanner used. These settings typically allow for near-isotropic voxels and high-quality coronal and sagittal multiplanar reconstructions as well as three-dimensional (3D)–rendered maximum intensity projection (MIP) and shaded surface display images, all of which can aid in diagnosis and in depicting findings for surgeons. A delayed contrast phase may be acquired to evaluate for periaortic enhancement, to detect an endoleak after endoluminal stent graft repair, or for routine evaluation of the solid organs of the abdomen if another diagnosis is suspected.

Many modern scanners have software to aid in selecting an appropriate peak kilovoltage (kVp) for the clinical application and patient size. When possible, a lower kVp (100 or 80 kVp when possible) is advised for CT angiography to maximize the photoelectric effect of iodine and provide high-quality arterial opacification.[2] Dual-energy CT

Table 1
Imaging protocols: abdominal aorta

CT Angiography	MR Angiography
Noncontrast phase	ECG gated when possible
Arterial phase: 4 mL/s injection rate, bolus tracking off descending aorta + 15-s delay	Axial and coronal T2 FSE and SSFP images
No oral contrast	Contrast-enhanced axial FS 3D GRE with gadofosveset trisodium
Slice thickness, 2-mm; reconstruction interval, 1 mm	3D MRA to include abdominal aorta through femoral arteries
Sagittal and coronal MPRs, 3D postprocessing for endoluminal measurements	Noncontrast MRA: QISS or TOF imaging
Delayed images in select cases[a]	Delayed images in select cases[a,b]

Abbreviations: 3D, three dimensional; ECG, electrocardiogram; FS, fat-saturated; FSE, fast spin echo; GRE, gradient recalled echo; MPR, multiplanar reconstruction; QISS, quiescent-interval single-shot; SSFP, steady-state free precession; TOF, time of flight.

[a] If an endoleak, inflammatory aortic aneurysm, or aortitis is suspected.

[b] Aortic inflammation or infection should ideally be evaluated using a standard extracellular gadolinium-based contrast agent when imaged with MRI.