# MR Imaging of the Thoracic Aorta

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**KEYWORDS**

• Thoracic aorta • MR imaging • Aortic pathology

**KEY POINTS**

- MR imaging allows for comprehensive evaluation of thoracic aorta without exposure to iodinated contrast or ionizing radiation.
- Basic knowledge of pulse sequences and common artifacts and ways to avoid them is essential for successful MR imaging of the aorta.
- Noncontrast magnetic resonance angiography (MRA) of the aorta can adequately answer clinical questions, even in scenarios where gadolinium administration is contraindicated.

## INTRODUCTION

Invasive imaging preceded noninvasive cross-sectional imaging in evaluation of thoracic aorta. Recently, advances in CT and MR imaging have significantly improved knowledge, understanding, and management of thoracic aortic diseases. Iodinated contrast-enhanced (CE) CT is readily available, provides superior spatial resolution, and constitutes the cornerstone for pre- and post-operative evaluation of the thoracic aorta. MR imaging provides morphologic and functional information without utilization of iodinated contrast or radiation exposure. MR imaging is, therefore, preferred in younger patients in whom annual follow-ups are required.

This article discusses MR imaging techniques, protocols, imaging planes, and application of MR imaging in the assessment of common thoracic aortic pathologies, such as aneurysms, aortic dissection, penetrating ulcers, congenital anomalies, and postoperative complications. Imaging artifacts that potentially lead to misdiagnosis and ways of overcoming these artifacts also are discussed.

## MR IMAGING TECHNIQUES

MR imaging of thoracic aorta is commonly used for interrogation of a variety of genetic, traumatic, atherosclerotic, inflammatory, and idiopathic disease processes. Although gadolinium-based contrast material is frequently used for thoracic aortic assessment, depending on the clinical scenario and patient specific factors, the clinical question about specific aortic pathology can be adequately answered even without gadolinium as needed. This section focuses on various MR sequences and their applications.

### *Black Blood Imaging*

Black blood (BB) images of blood vessels are acquired with double-inversion recovery prepulse technique.[1] This flow-sensitive technique uses 2 180° inversion recovery prepulses to null the signal of flowing blood:

- The first prepulse is not slice selective and inverts the longitudinal magnetization vector (Mz) in the entire body.

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- The second prepulse is slice selective and inverts Mz back to its original orientation but only in the selected slice.

The excitation pulse is applied when Mz of blood that was initially outside the imaging slice has relaxed to zero, therefore not generating any signal. If there is flow, this blood from outside has replaced the blood in the imaging slice, resulting in nulled (dark) blood pool signal.

For routine BB imaging of the thoracic aorta, the authors use a vectorcardiogram (VCG)-gated proton density–weighted 2-D fast spin-echo (FSE) sequence with a slice thickness of 6 to 8 mm. The routine protocol includes a stack of 6- to 8-mm slices in the transverse plane of the chest and in the sagittal oblique (candy cane) view of the aortic arch. VCG gating increases imaging time but, however, significantly reduces motion artifact. Single-shot FSE (SSFSE) sequences are much faster than basic FSE sequences and allow for acquisition of the entire imaging stack in a single breath-hold. In the acute setting, it is recommended to acquire T1-weighted BB images with fat saturation, to increase the conspicuity of aortic wall hematoma.[2] T2-weighted BB imaging with fat saturation can demonstrate aortic wall or periaortic edema in inflammatory disorders.[3,4]

Despite being a robust and established technique, BB images are prone to artifact. Common issues are incomplete nulling of the blood pool, particularly if flow is aligned with the imaging plane, which is commonly encountered with imaging of the descending aorta in the candy cane plane and can be alleviated by decreasing the slice thickness of the second (slice-selective) inversion recovery prepulse (BB slice thickness) (**Fig. 1**). Another issue is incomplete visualization of the vessel wall, which can be resolved by increasing the BB slice thickness.

## *Bright Blood Imaging*

VCG-gated cine acquisitions with 2-D steady state free precession (SSFP) sequences generate time-resolved images, which help not only depict the anatomy of thoracic aorta (**Fig. 2**) but also visualize flow jets, without use of gadolinium-based contrast material. Signal intensity of the blood pool on SSFP images is inherently high and relatively independent from inflow effects, which is explained by T2/T1-weighted image contrast, which is particularly high for blood and all fluids. 2-D SSFP cine imaging is used to evaluate aortic size, depict aneurysms, and demonstrate dissection flaps and any filling defects, such as

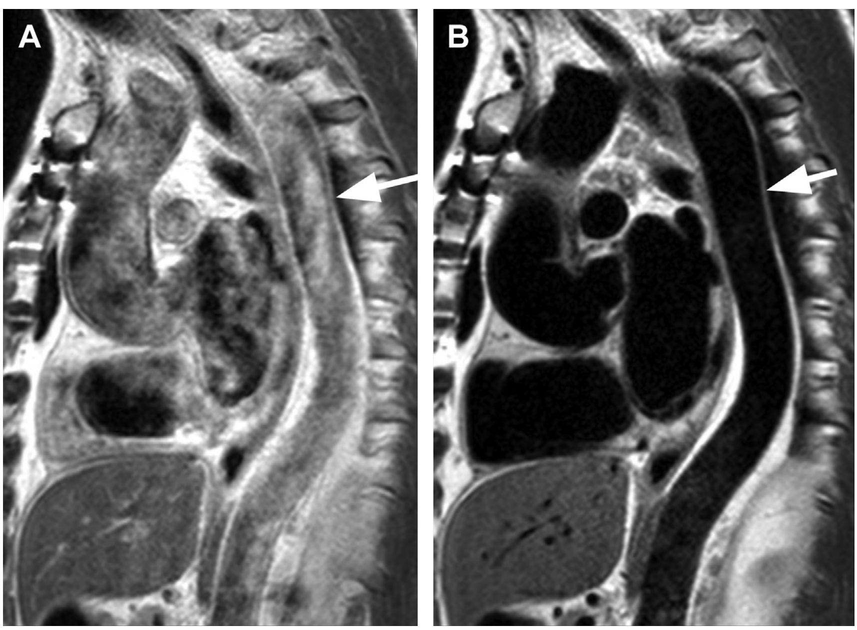


**Fig. 1.** A 45-year-old man with ascending aortic aneurysm. (*A*) Double-inversion BB image in sagittal oblique plane demonstrating high signal intensity within the blood in the thoracic aorta (*arrow*), due to inadequate nulling of the blood pool. (*B*) The same sequence was repeated after reducing the BB slice thickness. Note the homogeneous suppression of blood pool (*arrow*). As a rule of thumb, BB slice thickness has been suggested as 1 to 1.5 times the image slice thickness for in plane flow.