dissections [186]. In addition, CT can detect concomitant coronary artery and/or branch vessel involvement as well as pericardial involvement and help identify entry tears. In patients suspected of having AAS, a CT scan is also useful to identify alternate diagnoses if the former is not visualized [187]. Furthermore, cardiac CT serves as a non-invasive alternative to invasive angiography to rule out coronary artery disease [188].

A contrast-enhanced arterial-phase series extending from the thoracic inlet to the level of the femoral artery is recommended in most cases. If the cerebral arterial circulation is not known, the scan can be extended cranially to cover the circle of Willis if the surgical procedure requires selective cerebral perfusion. Furthermore, there is an association of an aortic and an intracranial aneurysm [189, 190]; although the radiologist should be aware of this association while reading the CT scan, the scientific evidence is not strong enough to recommend a screening test for an intracranial aneurysm in patients with an aortic aneurysm.

If an AAS is suspected, a non-contrast series prior to the arterial-phase series is usually performed to better distinguish a possible IMH from other causes of aortic wall thickening; further, a portal venous-phase series can be useful to determine malperfusion of the abdominal organ. Also, a native CT series should be performed prior to the arterial-phase series at the first postoperative scan to reliably distinguish foreign material from contrast agent. Additionally, a venous-phase series using computed tomography angiography (CTA) can provide important information to assess false lumen flow particularly after an operation for type A or in type B with a small entry tear size and in the diagnosis of endoleaks after TEVAR implantation.

Magnetic resonance imaging. Magnetic resonance imaging is the only other modality besides CT that can provide 3D images with sufficient temporal/spatial resolution and anatomical coverage of the aorta to determine vessel enlargement and vessel wall changes. Due to its better soft-tissue contrast, MRI is the preferred modality to characterize aortic wall changes associated with inflammation. Further, MRI provides physiological assessment of ventricular and valvular function and quantification of blood flow. Similar to CT, ECG-triggered acquisition should be chosen if the aortic root and ascending aorta require imaging. An MRI does not require ionizing radiation. Therefore, MRI is often the first choice for the evaluation of congenital aortic malformations and is recommended for serial imaging in young patients or in patients in whom a radiation dose should be avoided (e.g. during pregnancy).

Limitations of MRI include the occurrence of artefacts in patients with stents and other metallic implants or devices. In addition, it has much longer acquisition times and lower spatial resolution compared to CT. Further, MRI has a limited ability to monitor and treat unstable patients in the scanner. Therefore, this modality is rarely used with patients suspected of AAS, especially when the patient is unstable.

Gadolinium-based intravenous contrast agents can be used to enhance MRI and are often used for MR angiography. Gadolinium-based intravenous contrast agents carry some risk for nephrogenic systemic fibrosis in patients with impaired renal function. The risk differs significantly between different types of gadolinium-based contrast agents. For agents with the lowest risk (like macrocyclic agents), assessment of renal function prior to MR scanning is not mandatory, and a patient should be encouraged not to refuse a clinically well-indicated enhanced MR examination to avoid a contrast agent [191].

An MRI can be performed without intravenous contrast, even for MR angiography. However, dedicated sequences such as native 3D TrueFISP or magnetization-prepared 3D non-balanced dual-echo Dixon are available to examine the aorta in the MR scanner without contrast agent (Fig. 8).

Transthoracic echocardiography. Transthoracic echocardiography is the most commonly used imaging modality for the initial examination of the thoracic aorta. It is particularly useful for visualizing the aortic root and ascending aorta as well as for assessing the anatomy and function of the aortic valve [164]. To visualize the mid-distal ascending aorta, it may be necessary to move the transducer to the upper intercostal spaces, whereas right parasternal views might help visualize the distal portion of the ascending aorta. Although TTE is not ideal for imaging the aortic arch, it can often visualize the vascular branches of the aortic arch and proximal descending aorta and aid in the diagnosis of coarctation of the aorta (CoA) and ductus arteriosus. Transthoracic echocardiography is portable and can be performed at the bedside with high spatial and temporal resolution. It is useful in the evaluation of complications such as aortic regurgitation, left ventricular (LV) dysfunction and cardiac tamponade. It is useful in the longitudinal monitoring of the aortic root and ascending aortic dilatation, provided these aortic segments are well visualized. Moreover, TTE is crucial for providing important information on ventricular as well as valve abnormalities in patients undergoing endovascular treatment [163, 166].

Transoesophageal echocardiography. Transoesophageal echocardiography provides high-resolution images of most of the thoracic aorta, except for a small segment of the ascending aorta distally due to acoustic shadowing of the trachea. It is also useful for a detailed understanding of aortic valve anatomy and function. Transoesophageal echocardiography is particularly useful in the intraoperative evaluation of patients with AAS to guide both surgical and endovascular repair strategies and to assess true and false lumens before and immediately after aortic repair. This imaging modality is very useful in intubated patients in the ICU, especially if the transfer of the patient to the radiology unit is hazardous because of haemodynamic instability.

Intravascular ultrasound. Intravascular ultrasound is useful in guiding the endovascular treatment of complex lesions of the thoraco-abdominal aorta because, in addition to assessing the landing zone, it can visualize aortic size, tortuosity, plaque burden, calcification, vascular branching and endovascular filling defects (e.g. thrombosis, entrapment valves). It is also useful in aortic dissection to differentiate between true and false lumen dissection. Thus, endovascular ultrasound can be used to guide endovascular or open repair. However, this imaging method is not widely used because of alternate possibilities and its cost.

Ultrasound of the abdominal aorta. Ultrasound is recommended for screening and monitoring of an abdominal aortic aneurysm [192], which is defined as >30 mm in diameter, using primarily an anterior–posterior diameter, and using the outer edge-to-outer edge measurement. Although it is an effective imaging modality with high diagnostic accuracy for detecting