

**American College of Radiology
ACR Appropriateness Criteria®
Suspected Thoracic Aortic Aneurysm**

Variant 1: Suspected thoracic aortic aneurysm. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
CTA chest with IV contrast	Usually Appropriate	☼☼☼
MRA chest with IV contrast	Usually Appropriate	○
MRA chest without IV contrast	Usually Appropriate	○
CT chest without IV contrast	May Be Appropriate	☼☼☼
US echocardiography transesophageal	May Be Appropriate	○
X-ray chest	May Be Appropriate	☼
CTA chest abdomen pelvis with IV contrast	May Be Appropriate (Disagreement)	☼☼☼☼☼
MRA chest abdomen pelvis with IV contrast	May Be Appropriate (Disagreement)	○
MRA chest abdomen pelvis without IV contrast	May Be Appropriate (Disagreement)	○
US echocardiography transthoracic resting	May Be Appropriate	○
CT chest abdomen pelvis without IV contrast	Usually Not Appropriate	☼☼☼☼
CT chest abdomen pelvis with IV contrast	Usually Not Appropriate	☼☼☼☼
CT chest abdomen pelvis without and with IV contrast	Usually Not Appropriate	☼☼☼☼
CT chest with IV contrast	Usually Not Appropriate	☼☼☼
CT chest without and with IV contrast	Usually Not Appropriate	☼☼☼
Aortography chest abdomen pelvis	Usually Not Appropriate	☼☼☼☼

SUSPECTED THORACIC AORTIC ANEURYSM

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Summary of Literature Review

Introduction/Background

Thoracic aortic aneurysms (TAAs) tend to be clinically silent, often discovered incidentally upon imaging for another cause, unlike abdominal aortic aneurysms (AAA) that may present with pain or a pulsatile abdominal mass [1]. Although individuals with TAA are generally asymptomatic, some patients may describe chest or back pain. When patients with known or suspected TAA present with sudden onset of pain, complications such as dissection, hemorrhage, or impending rupture should be considered [2,3]. Although uncommon, cases involving a large TAA may present with anatomical mass effect, which can manifest due to compression of adjacent structures such as the esophagus, blood vessels, or nerves [4]. As intervention planning and follow-up are not within the scope of this document, readers should refer to the ACR Appropriateness Criteria[®] “[Thoracic Aorta Interventional Planning and Follow-up](#)” [5].

Normal thoracic aorta diameter varies from the aortic sinuses to the diaphragm, decreasing in size as it courses distally. The adult thoracic aorta diameter is dependent on the individual, but measures between 3.5 to 4.0 cm at the aortic root, and tapers distally to measure between 2.4 to 2.7 cm at the level of the diaphragm, with larger diameters seen particularly in older males [6-8]. Aortic dilatation of <50% over normal qualifies as aortic ectasia, whereas TAA are diagnosed when there is at least 50% enlargement of the aortic lumen, or alternatively when the aortic diameter is more than two standard deviations above the mean for the patient’s sex and age [4,9]. Abnormal dilatation of the thoracic aorta may be focal or relatively diffuse, and both fusiform and saccular aneurysms can occur. The most common locations for TAA are in the ascending aorta, followed by the descending aorta, and are seen in similar incidence in the aortic arch and thoracoabdominal aorta [10,11] Larger aneurysms that reach >5 cm in diameter, and TAAs that increase in size >0.5 cm per year, trigger an evaluation for possible intervention due to their association with increased morbidity and mortality [4,12]. See the ACR Appropriateness Criteria[®] “[Thoracic Aorta Interventional Planning and Follow-up](#)” [5].

The true incidence of TAA in the general population is unknown because most cases are asymptomatic and may go undiscovered. Review of the published literature reveals the incidence to be approximately 10.7 to 16.3 cases per 100,000 in men and between 7.1 to 9.1 cases per 100,000 in women per year, with both incidence and surgical interventions increasing over time [2,13,14]. Other reports have estimated the incidence of TAA-related mortality to be on the decline, albeit with marked inequality between countries and patient demographic groups [15]. Regardless of the exact incidence today, clinicians are frequently tasked with working up suspected or incidentally found TAA and should be familiar with the existing diagnostic modalities.

Discussion of Procedures by Variant

Variant 1: Suspected thoracic aortic aneurysm. Initial imaging.

Radiography

Patients presenting to a clinic or the emergency department receive chest radiographs (CXRs) for a variety of indications. Regardless of symptoms, or lack thereof, abnormalities seen on a screening CXR are often the impetus for further imaging and clinical workup of TAA. Findings such as a widened mediastinum, mass effect or distortion of para-aortic structures, and aortic tortuosity or widening can signal the need for further clinical and

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imaging evaluation of possible aortic aneurysm [16]. CXRs, though neither as sensitive nor specific as cross-sectional imaging, are also helpful to exclude other thoracic pathology and to rule out various causes of patient presentation, such as pneumothorax, osseous abnormalities (for example, fractures), and pneumonia.

TTE and TEE

Resting transthoracic (TTE) and transesophageal (TEE) echocardiography are useful imaging modalities for both initial workup of suspected TAA and for follow-up evaluation of known TAA. Additionally, ultrasound (US) is often readily available at the bedside and can provide rapid results when patients are unstable or may require urgent surgery. TTE is less invasive than TEE; both modalities are useful in ruling out TAA. However, imaging with TTE may be limited for obese or intubated patients and for those who present with physical limitations to ultrasonographic evaluation, such as chest wall alterations from recent surgery, pneumothorax, or emphysema. [17,18]. Likewise, esophageal varices are a relative contraindication for TEE due to bleeding risk. TTE allows for evaluation of the aortic root, important anatomy to visualize due to the frequency of associated findings such as valvular abnormalities, incompetence, and regurgitation. However, the transthoracic approach is often limited by superimposed soft-tissue structures for evaluating the ascending and descending aortic arch [11].

When patients are being evaluated with US, long axis views of the aorta are obtained from the aortic sinuses through the descending aorta. Complete evaluation of the aorta branch vessels is necessary to evaluate for aneurysm involvement, thrombus, dissection, and stenosis, as well as for treatment planning. One limitation to US evaluation is decreased sensitivity for pathology in the aortic arch [19]. An additional “blind spot” for US is the anterior aortic arch, which limits sonographic imaging due to the trachea and left main bronchus blocking sound waves between the esophagus and aorta [18].

CT and CTA

In patients who are found to have TAA on US, or in cases when more information is needed after CXR or clinical examination, computed tomography (CT) can be a high-quality imaging tool for more detailed evaluation, therapy planning, and follow-up. Nonenhanced CT with multiplanar reconstructions is often adequate for initial diagnosis of suspected TAA and for further delineation of any additional abnormal aortic findings, such as atherosclerotic plaque seen on US or CXR, but is limited in evaluation of acute TAA complications [20]. Intravenous (IV) contrast should be administered to patients who can tolerate iodinated contrast so that CT angiography (CTA) may be performed [21].

For the purposes of distinguishing between CT and CTA, the ACR Appropriateness Criteria topics use the definition in the [Practice Parameter for the Performance and Interpretation of Body Computed Tomography Angiography \(CTA\)](#) [22]:

“CTA uses a thin-section CT acquisition that is timed to coincide with peak arterial or venous enhancement. The resultant volumetric dataset is interpreted using primary transverse reconstructions as well as multiplanar reformations and 3-D renderings.”

All procedure elements are essential: (1) timing, (2) recons/reformats, and (3) 3-D renderings. Standard CTs with contrast also include timing issues and recons/reformats. Only in CTA, however, is 3-D rendering a **required** element. This corresponds to the definitions that CMS has applied to the CPT codes.

CTA has the additional advantage of high sensitivity for thrombus and dissection, and the delayed phase can be used to diagnose aortic wall thickening and enhancement in cases of infectious or inflammatory aortitis [23]. In certain patients, multiphase CTA may be useful to further characterize complications in patients with known or suspected TAA [24]. CTA is also useful for imaging the branch vessels, and often is employed to visualize the entire aorta from aortic sinus through the iliac bifurcation and into the lower extremities if needed [25-27]. Additionally, multiphase CTA, including delayed-contrast images, is perhaps the best imaging tool for evaluation of patients who have had either open or endovascular TAA repair, and for patients who need preoperative treatment planning; however, this is discussed in greater detail in the thoracic aortic intervention planning and follow-up document [28-31]. See the ACR Appropriateness Criteria® [“Thoracic Aorta Interventional Planning and Follow-up”](#) [5]. Limitations of CTA include streak artifact from implanted devices, variable quality of images through the aortic root and coronary vessels due to cardiac motion in non-gated studies, and the need for IV iodinated contrast [32-34]. Electrocardiogram (ECG)-gated CTA is often used to minimize cardiac motion artifact and to allow for accurate orthogonal measurement of the ascending thoracic aorta [35,36].

A routine CT of the chest, abdomen, and pelvis with IV contrast in the venous phase, as is commonly ordered to evaluate the soft tissues, may reveal TAA, but should not be ordered without additional contrast phases if TAA or other aortic pathology is highest on the differential diagnosis list [37]. Images may be obtained of the entire aorta because patients with TAA have an increased incidence of AAA, as well as aneurysmal disease elsewhere in the body [38].

MRA

Magnetic resonance angiography (MRA) is an increasingly employed modality for diagnosing, characterizing, and after TAA [39]. Although certain MRA sequences can be performed without IV contrast enhancement, the use of IV gadolinium-contrast medium provides for similar sensitivity and specificity to that of CTA while also allowing for postprocessing, which can generate 3-D reconstruction, maximum intensity projections and multiplanar reconstructions [40]. Image acquisition times, though still longer than CTA, are becoming faster as new protocols are implemented and new technology reaches the market [41,42]. ECG-gated MRA image acquisition and orthogonal measurement allows for increased accuracy of aortic diameter measurement than nongated studies and axial image measurements [43].

Few contraindications exist for MRA; however, there is increased risk of nephrogenic systemic fibrosis in patients with severely impaired renal function. Standard practice is to avoid the administration of gadolinium-based contrast in patients with glomerular filtration rate $<30 \text{ mL/min/1.73m}^2$ [44,45]. MRA is of sufficient resolution to be used for evaluating TAA in patients who have received certain nitinol stents [46]. MRA also provides high-resolution images of the surrounding thoracic structures and can help evaluate aortic and periaortic inflammation or infection.

Aortography

Conventional catheter arteriography of the aorta may provide useful information about TAA and also provides access for intervention when indicated, particularly in patients with end-organ ischemia. Iodinated contrast doses for arteriography can vary widely, but very low doses may be used for patients with poor renal function or for those who have received a kidney transplant. Limitations of catheter-based arteriography include the potential to underestimate the aortic lumen diameter when thrombus is present, as well as the need for femoral, brachial or radial arteriotomy to allow for catheter placement [47,48]. Additionally, catheter arteriography does not adequately evaluate atherosclerotic disease or the soft tissues in the thorax outside the aortic lumen [49]. Rare complications may occur when catheterizing the aorta, such as dissection and stroke, warranting caution when being used for diagnostic evaluation.

Summary of Recommendations

- CTA chest or MRA chest is recommended for radiological diagnosis of suspected thoracic aortic aneurysm.

Summary of Evidence

Of the 50 references cited in the *ACR Appropriateness Criteria® Suspected Thoracic Aortic Aneurysm* document, 10 are categorized as therapeutic references, including 3 good-quality studies, and 1 quality study that may have design limitations. Additionally, 39 references are categorized as diagnostic references, including 4 well-designed studies, 4 good-quality studies, and 10 quality studies that may have design limitations. There are 27 references that may not be useful as primary evidence. There is 1 reference that is a meta-analysis study.

The 50 references cited in the *ACR Appropriateness Criteria® Suspected Thoracic Aortic Aneurysm* document were published from 1994 to 2016.

Although there are references that report on studies with design limitations, 11 well-designed or good-quality studies provide good evidence.

Appropriateness Category Names and Definitions

Appropriateness Category Name	Appropriateness Rating	Appropriateness Category Definition
Usually Appropriate	7, 8, or 9	The imaging procedure or treatment is indicated in the specified clinical scenarios at a favorable risk-benefit ratio for patients.
May Be Appropriate	4, 5, or 6	The imaging procedure or treatment may be indicated in the specified clinical scenarios as an alternative to imaging procedures or treatments with a more favorable risk-benefit ratio, or the risk-benefit ratio for patients is equivocal.
May Be Appropriate (Disagreement)	5	The individual ratings are too dispersed from the panel median. The different label provides transparency regarding the panel's recommendation. "May be appropriate" is the rating category and a rating of 5 is assigned.
Usually Not Appropriate	1, 2, or 3	The imaging procedure or treatment is unlikely to be indicated in the specified clinical scenarios, or the risk-benefit ratio for patients is likely to be unfavorable.

Relative Radiation Level Information

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level (RRL) indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Patients in the pediatric age group are at inherently higher risk from exposure, both because of organ sensitivity and longer life expectancy (relevant to the long latency that appears to accompany radiation exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower as compared to those specified for adults (see Table below). Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® [Radiation Dose Assessment Introduction](#) document [50].

Relative Radiation Level Designations		
Relative Radiation Level*	Adult Effective Dose Estimate Range	Pediatric Effective Dose Estimate Range
○	0 mSv	0 mSv
⊗	<0.1 mSv	<0.03 mSv
⊗⊗	0.1-1 mSv	0.03-0.3 mSv
⊗⊗⊗	1-10 mSv	0.3-3 mSv
⊗⊗⊗⊗	10-30 mSv	3-10 mSv
⊗⊗⊗⊗⊗	30-100 mSv	10-30 mSv

*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (eg, region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as "Varies".

Supporting Documents

For additional information on the Appropriateness Criteria methodology and other supporting documents go to www.acr.org/ac.

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The ACR Committee on Appropriateness Criteria and its expert panels have developed criteria for determining appropriate imaging examinations for diagnosis and treatment of specified medical condition(s). These criteria are intended to guide radiologists, radiation oncologists and referring physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient's clinical condition should dictate the selection of appropriate imaging procedures or treatments. Only those examinations generally used for evaluation of the patient's condition are ranked. Other imaging studies necessary to evaluate other co-existent diseases or other medical consequences of this condition are not considered in this document. The availability of equipment or personnel may influence the selection of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by the FDA have not been considered in developing these criteria; however, study of new equipment and applications should be encouraged. The ultimate decision regarding the appropriateness of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.