

**American College of Radiology
ACR Appropriateness Criteria®
Pulsatile Abdominal Mass, Suspected Abdominal Aortic Aneurysm**

Variant 1: Pulsatile abdominal mass, suspected abdominal aortic aneurysm.

Radiologic Procedure	Rating	Comments	RRL*
US aorta abdomen	9		O
CTA abdomen with IV contrast	8		☢ ☢ ☢
MRA abdomen without and with IV contrast	8		O
CT abdomen without IV contrast	7		☢ ☢ ☢
CT abdomen with IV contrast	7		☢ ☢ ☢
CT abdomen without and with IV contrast	7		☢ ☢ ☢ ☢
MRA abdomen without IV contrast	7		O
Aortography abdomen	4		☢ ☢ ☢
FDG-PET/CT abdomen	2		☢ ☢ ☢ ☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

PULSATILE ABDOMINAL MASS, SUSPECTED ABDOMINAL AORTIC ANEURYSM

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Summary of Literature Review

Introduction/Background

Clinical palpation of a pulsating abdominal mass alerts the clinician to the presence of a possible abdominal aortic aneurysm (AAA), a common vascular disorder seen in older individuals, more commonly in male patients with a history of hypertension and smoking [1-3]. However, the finding of a pulsatile abdominal mass can also be caused by a tortuous abdominal aorta or transmitted pulsations from the aorta to a nonvascular mass [4].

Generally, an arterial aneurysm is defined as a localized arterial dilatation $\geq 50\%$ of the normal diameter. The term *ectasia* is applied to arterial dilatations $< 50\%$ of the expected normal diameter. The normal dimension of the infrarenal abdominal aorta is up to 2 cm in the anteroposterior (AP) diameter. Thus, the infrarenal abdominal aorta is considered aneurysmal if it is ≥ 3 cm in diameter or ectatic if it is between 2 and 3 cm in diameter [5]. The absolute threshold for aneurysm decreases along the length of the aorta and is about 10% smaller in women than in men [6].

Imaging studies are important in diagnosing the cause of a pulsatile abdominal mass and, if an AAA is found, in determining its size, involvement of abdominal branches (both visceral and parietal), and any associated significant stenosis or aneurysm involving abdominal visceral and extremity arteries that may aid in treatment planning [7]. Imaging studies should also categorize the extent of aneurysm (ie, infrarenal aorta; infrarenal aorta and iliac artery; isolated iliac artery; or juxtarenal, suprarenal, or thoracoabdominal aorta) [8]. Imaging can also be used for routine surveillance of AAAs.

Currently, elective repair is considered for AAAs ≥ 5.5 cm in diameter [9]. For smaller AAAs, periodic surveillance is recommended at intervals based on their maximum size [10]: every 6 months for those 4.5 to 5.4 cm in diameter, every 12 months for those 3.5 to 4.4 cm in diameter, every 3 years for those 3.0 to 3.4 cm in diameter, and every 5 years for those 2.6 to 2.9 cm in diameter.

Population-based ultrasound (US) screening studies have been recommended and have proved cost-effective for male patients > 65 years of age [11-14], despite the fact that one-fifth of all ruptured AAAs occur in these patients [15]. The risk of AAA increases with a history of hypertension, smoking, 3-vessel coronary artery disease, and first-degree male relative with AAA [16-18]. For AAAs 3 to 5.5 cm in diameter, periodic US or computed tomography (CT) imaging at 6- to 12-month intervals, depending on the rate of aneurysm enlargement on prior studies, is recommended. Other aneurysm characteristics, including saccular morphology of smaller aneurysms, have been associated with an increased risk of rupture below the 5.5-cm size threshold for intervention, and CT angiography (CTA) may be helpful in describing aneurysm morphology in patients with 4.0- to 5.5-cm aneurysms before continued US surveillance [19,20]. When aneurysms have reached the size threshold for intervention (5.5 cm) or are considered clinically symptomatic, additional preintervention imaging studies should be performed to help define the optimal surgical or endovascular approach.

For preintervention studies, either multidetector CT (MDCT) or CTA is the optimal choice. Magnetic resonance angiography (MRA) may be substituted if CT cannot be performed (for example, because the patient is allergic to iodinated contrast material). However, MRA is usually performed with gadolinium contrast material, which is not

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suitable for patients with severe renal insufficiency. In such patients, the center where it is being performed must be able to perform MRA of AAAs without the use of gadolinium contrast material [21,22].

Other types of imaging studies that have been used in the past to delineate AAAs—including abdominal radiographs, intravenous urography, and blood pool radionuclide imaging—are not recommended for diagnosis, surveillance, or preintervention imaging.

Catheter arteriography has very limited utility in the preintervention evaluation of patients with AAAs, its sole utility being in patients with significant contraindications to both CTA (significant renal dysfunction) and MRA (significant renal dysfunction, cardiac pacemakers, claustrophobia). In patients with significant renal dysfunction, the combination of CT and the lower load of iodinated contrast material that can be used with intra-arterial injection may decrease the risk of contrast-induced nephropathy.

Many imaging studies for assessing AAA can also identify other diseases that could affect preoperative management of AAA, such as coronary artery disease [23] and thoracic aortic aneurysm [24]. Screening for AAA can also be performed during unrelated imaging studies, such as transthoracic echocardiography [25-28], peripheral vascular US [29], and imaging studies to assess coronary artery disease [30,31] and stroke or transient ischemic attack [32]. Aortic root size measured by transthoracic echocardiography has been shown to be an independent predictor of AAA [33].

Ultrasound

US examination of the abdominal aorta should be a dedicated examination and not a component of a generalized abdominal US study. If possible, complete longitudinal evaluation of the full extent of the aneurysm and involvement of common iliac arteries should be performed. These studies should include a measurement of the leading-edge to leading-edge AP diameter in the proximal, mid, and distal infrarenal aorta and of the common iliac arteries. The presence of mural thrombus has been associated with expansion rates and should be delineated [34]. Right and left kidneys should be imaged to determine size, parenchymal thickness, and presence or absence of hydronephrosis. In order to permit US to be used instead of CT for AAA follow-up, interindividual reproducibility of diameter measurements should be within ≤ 4 mm [35]. US tends to underestimate the size of aneurysms by 4 mm compared with CTA [36]. Color Doppler imaging is not a necessary component of sonographic screening or surveillance examination. New 3-D volumetric US techniques offer similar measurements but speed up imaging significantly [37,38].

Approximately 5% of AAAs will be juxtarenal or juxta/suprarenal [39], and it may not be possible to accurately delineate the upper margin of such aneurysms or the precise involvement of abdominal visceral branches by sonographic study. That is why a more definitive study, such as CTA, should be performed prior to intervention.

Computed tomography

CT abdomen without contrast is diagnostically equivalent to US for AAA detection and is recommended in patients for whom US is not suitable. CT may be used as a diagnostic and preintervention study, suitable for patients presenting with a pulsatile abdominal mass with or without clinical suspicion of contained aortic rupture and in planning endovascular or surgical intervention in patients with AAAs >5.5 cm in external AP diameter [40,41]. In tortuous aneurysms, where a single dimension may be artifactually accentuated by the curvature of the aorta, the diameter of the aorta should be measured using multiplanar reformatted images that have been angle corrected for aortic curvature or curved planar reformatted images with automated centerline 3-D software [42,43].

CT abdomen with contrast provides some of the information that a CTA provides, such as aneurysm size, presence or absence of thrombus, and presence or absence of a dissection flap [41,44]. CT abdomen with contrast does not give the precise size measurements, may not provide as much information about branch vessel involvement, and will not give the smooth 3-D renderings that a CTA will provide. However, CT abdomen with contrast performed in the portal venous phase provides more useful diagnostic information about extra-aortic pathology, such as liver, renal, and splenic pathology.

CT abdomen without and with contrast should be performed in patients with suspected contained rupture. CT without contrast is performed prior to CT with contrast to better diagnose dissecting hematoma in the lining of the intra-aortic thrombus (the crescent sign) and other signs consistent with imminent or contained rupture [45,46], including a draped aorta and adjacent vertebral erosion [47].

Computed tomography angiography

For the purposes of distinguishing between CT and CTA, ACR AC topics use the definition in the [Practice Parameter for the Performance and Interpretation of Body Computed Tomography Angiography](#) [48]:

“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 3D renderings.”

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

Contrast-enhanced multidetector CTA is the best diagnostic and preintervention planning study, accurately delineating the location, size, and extent of the aneurysm and the involvement of branch vessels, allowing for accurate quantitative 3-D measurements [21,49]. CTA can also assess thrombus in the aneurysm. The presence of thrombus affects the hemodynamic properties of the aorta [50]. Larger thrombus and eccentric thrombus seem to be associated with rapid enlargement of the aneurysm and increased incidence of cardiovascular events [51-53]. There are several research protocols that use modern CT technologies. Multiphase MDCT can assess compressibility of a thrombus that can act as a biomechanical buffer [54]. Using delayed imaging, aortic wall enhancement is associated with AAA diameter, biochemical markers of inflammation, and thrombus size [55]. A grading scale based on CTA-derived biomechanical markers may predict aneurysm rupture [56]. Short-term follow-up by CTA does not decrease the suitability of aneurysms for endovascular intervention [57].

In patients with a suspected thoracoabdominal aortic aneurysm, CTA may be tailored for an angiographic examination of the chest, abdomen, and pelvis [44,58,59]. In patients with suspected coexistent lower-extremity arterial disease, the arterial system from the diaphragm to the feet can be studied with MDCT or CTA [60].

Volume rendering, subvolume maximum-intensity projection (MIP), and curved planar reformations are integral components of the 3-D analysis. Three-dimensional analysis is useful for measuring the correct size of an AAA [61]. Semiautomated measurements of vessel diameter and length in relation to the proximal and distal aneurysm margins and branch vessels can be readily obtained with software supplied by multiple vendors. Additional research methods include electrocardiogram-gated MDCT that can assess decreased distensibility of aortic aneurysms [62]. Advanced postprocessing of CT data can assess wall stress. Rapidly expanding AAAs have higher shoulder and wall stress [63,64]. Calcification of the aneurysm increases wall stress and decreases the biomechanical stability of the AAA [65]. AAA peak wall stress at maximal blood pressure is higher in symptomatic or ruptured aneurysms than in asymptomatic aneurysms [66,67].

In patients who have a contained rupture, a rapid CT angiographic study provides a template for decision-making about endovascular aneurysm repair or surgical aneurysmectomy [68].

Dual-energy CT and spectral CT have promise in the evaluation of patients with AAA. Both have the ability to create virtual noncontrast images, eliminating the need for true noncontrast images, with a potential for radiation dose reduction [69].

Magnetic resonance angiography

Contrast-enhanced MRA is an alternative and effective diagnostic and preintervention study [70]. The acquisition speed and spatial resolution of contrast-enhanced MRA has improved with the introduction of parallel imaging techniques, narrowing the gap with CTA in relation to image quality [71]. The introduction of blood pool contrast agents now enables longer image acquisition to improve image resolution [72]. Caution should be used in patients with severe renal dysfunction, generally considered as estimated glomerular filtration rate <30 mL/kg/min, who may be at risk for nephrogenic systemic fibrosis [73]. In these patients, a non-contrast-enhanced study may be substituted. Sequences and imaging expertise required for a full evaluation of AAA without contrast are becoming more mainstream.

Three-dimensional display techniques, including multiplanar reformation, MIP display, and volume rendering, are integral to the display and analysis of 3-D MRA. Cine techniques can also assess distensibility and, with suitable measurements of central venous pressure, can assess aortic compliance [74]. Vessel wall shear stress can also be measured using newer 4-D flow-sensitive MRI techniques [75].

Catheter arteriography (aortography abdomen)

Patients with significant contraindications to both CTA and MRA may have diagnostic catheter arteriography performed with a relatively low contrast material load following US documentation of AAA and/or noncontrast CT findings [76]. Carbon dioxide may also be used as an alternative contrast agent for arteriography [77].

Catheter arteriography may not demonstrate the aneurysm diameter accurately, as only the contrast column of an aneurysm containing lining mural thrombus may be displayed. In patients with marginal renal function, rapid intra-arterial injection of a relatively low volume of dilute contrast material from a catheter located in the mid descending thoracic aorta can be used to obtain a diagnostic CTA study, a technique called catheter-directed CTA [78,79].

Positron emission tomography

Although primarily a research tool, positron emission tomography (PET) using fluorine-18-2-fluoro-2-deoxy-D-glucose (FDG) imaging has promise in the evaluation of patients with AAA. Increased metabolic activity and FDG uptake (maximum standardized uptake value >2.5) are noted in aneurysms [80,81] and are even higher in infected aneurysms, inflammatory aneurysms, and symptomatic aneurysms and correlate well with histologic and metabolic evidence of inflammation [82,83]. Increased FDG uptake is also seen in areas of high wall stress and rupture [84]. Aneurysm calcification is unrelated to FDG uptake [80]. More recently, FDG uptake has not been shown to be a predictor of aneurysm growth [42].

Summary of Recommendations

- The consensus of the literature supports aortic US as the initial imaging modality of choice when a pulsatile abdominal mass is present. Noncontrast CT may be substituted in patients for whom US is not suitable (for example, those with obese body habitus).
- US is recommended as a screening technique in the Medicare-eligible male population at highest risk.
- For definitive diagnosis and preintervention imaging, CTA and MRA are recommended.
- Currently, CTA is regarded as the superior test, as it is readily available, is robust, and provides high-spatial-resolution 3-D displays suitable for interventional planning as well as delineation of pathology in abdominal visceral arterial branches and extremity outflow vessels.
- Contrast-enhanced MRA has improved significantly in terms of speed and spatial resolution with the advent of parallel processing techniques and blood pool contrast agents. It may replace CTA for interventional planning in patients for whom iodinated contrast is contraindicated.
- Noncontrast MRA sequences for full evaluation of AAA are becoming more mainstream and should be performed only in centers with expertise in this technique.
- Appropriate preintervention measurements of the aortoiliac arterial system can be obtained with either technique.
- Both CTA and MRA can be used for thoracoabdominal aortic and extremity studies, all in the same imaging session.
- FDG-PET remains primarily a research tool but shows promise for assessing the metabolic activity of aneurysms.

Summary of Evidence

Of the 84 references cited in the *ACR Appropriateness Criteria[®] Pulsatile Abdominal Mass Suspected AAA* document, 1 is a good-quality therapeutic reference. Additionally, 82 references are categorized as diagnostic references including 10 good-quality studies, and 15 quality studies that may have design limitations. There are 56 references that may not be useful as primary evidence. One reference is a meta-analysis study.

The 84 references cited in the *ACR Appropriateness Criteria[®] Pulsatile Abdominal Mass Suspected AAA* document were published from 1984-2016.

Although there are references that report on studies with design limitations, 22 well designed or good quality studies provide good evidence.

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.

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.