American College of Radiology
ACR Appropriateness Criteria®

Pulsatile Abdominal Mass, Suspected Abdominal Aortic Aneurysm

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

Procedure	Appropriateness Category	Relative Radiation Level
US aorta abdomen	Usually Appropriate	O
MRA abdomen and pelvis with IV contrast	Usually Appropriate	O
MRA abdomen and pelvis without and with IV contrast	Usually Appropriate	O
MRA abdomen and pelvis without IV contrast	Usually Appropriate	O
CTA abdomen and pelvis with IV contrast	Usually Appropriate	☢☢☢☢
CTA abdomen and pelvis without and with IV contrast	Usually Appropriate	☢☢☢☢
MRI abdomen and pelvis with IV contrast	May Be Appropriate	O
MRI abdomen and pelvis without and with IV contrast	May Be Appropriate	O
MRI abdomen and pelvis without IV contrast	May Be Appropriate	O
CT abdomen and pelvis with IV contrast	May Be Appropriate	☢☢☢
CT abdomen and pelvis without IV contrast	May Be Appropriate	☢☢☢
CT abdomen and pelvis without and with IV contrast	May Be Appropriate	☢☢☢☢
US intravascular aorta abdomen	Usually Not Appropriate	O
Aortography abdomen	Usually Not Appropriate	☢☢☢
Radiography abdomen and pelvis	Usually Not Appropriate	☢☢☢
FDG-PET/CT skull base to mid-thigh	Usually Not Appropriate	☢☢☢☢

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Summary of Literature Review

Introduction/Background

A pulsatile abdominal mass identified on physical examination may indicate the presence of an abdominal aortic aneurysm (AAA) [1,2]. Most AAAs are clinically silent and incidentally discovered [3-5]. An aortic aneurysm is broadly defined as a segmental, full-thickness dilation of the aorta with a maximal diameter >1.5 times larger than the adjacent normal segment [6]. The majority of AAAs are fusiform in morphology, attributable to degenerative and atherosclerotic changes in the aortic wall, and located in the infrarenal abdominal aorta, in which an aortic diameter ≥3.0 cm is the threshold size for diagnosis [3,7-10]. The prevalence of AAA in persons >65 years of age ranges from 1.7% to 4.5% for men and 0.5% to 1.3% for women [3,4,11]. Major risk factors for AAA include advanced age, male sex, smoking, and family history of AAA [9]. The natural history of AAA is progressive expansion and potential rupture, which is a medical emergency with high mortality [9]. Indications for open or endovascular repair of nonruptured AAA include an aortic diameter ≥5.5

cm in men or ≥5.0 cm in women, onset of symptoms portending rupture, and rapid aneurysm growth [7,10].

In cases of suspected AAA, imaging is required to confirm the diagnosis and characterize the aneurysm to inform management planning. This document focuses on imaging evaluation for the initial diagnosis of nonruptured AAAs. For information on follow-up after initial diagnosis and interventional planning of AAAs, please see the ACR Appropriateness Criteria® topics on "Abdominal Aortic Aneurysm Follow-up (Without Repair)" [12] and "Abdominal Aortic Aneurysm: Interventional Planning and Follow-Up" [13].

Special Imaging Considerations

Measurement Technique: Maximum aortic diameter is the determinant parameter for AAA diagnosis; however, standardization of measurement technique is lacking [14-16]. There is general consensus that maximum aortic diameter should be measured in the plane perpendicular to the longitudinal axis of the aorta [7,8,10,17]. Measurements obtained in the axial plane relative to the long axis of a patient's body may overestimate aortic diameter in tortuous aortas. For cross-sectional imaging procedures, it is recommended that maximum aortic diameter be measured perpendicular to the centerline of the aorta using 3-D and multiplanar reformatted images when feasible [18,19]. There is, however, no consensus on whether the aortic wall should be included in aortic diameter measurements across imaging modalities. Diameter measurements between the inner-to-inner (ITI) aortic wall can be 3 to 6 mm smaller than outer-to-outer (OTO) wall measurements, with leading-to-leading (LTL) edge measurements being intermediate between the two [10,16]. In the absence of a global standard for measuring aortic diameter, it is imperative to consistently use one measurement technique and document the method employed [14].

For the purposes of distinguishing between CT and CT angiography (CTA), ACR Appropriateness Criteria topics use the definition in the ACR–NASCI–SIR–SPR Practice Parameter for the Performance and Interpretation of Body Computed Tomography Angiography (CTA) [20]:
"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 elements are essential: 1) timing, 2) reconstructions/reformats, and 3) 3-D renderings. Standard CTs with contrast also include timing issues and reconstructions/reformats. Only in CTA, however, is 3-D rendering a required element. This corresponds to the definitions that the CMS has applied to the Current Procedural Terminology codes.

Initial Imaging Definition

Initial imaging is defined as imaging at the beginning of the care episode for the medical condition defined by the variant. More than one procedure can be considered usually appropriate in the initial imaging evaluation when:

- There are procedures that are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care)

OR

- There are complementary procedures (ie, more than one procedure is ordered as a set or simultaneously wherein each procedure provides unique clinical information to effectively manage the patient's care).

Discussion of Procedures by Variant

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

Variant 1: Pulsatile abdominal mass, suspected abdominal aortic aneurysm. Initial imaging. A. Aortography abdomen

Although AAAs can be diagnosed by catheter-based aortography of the abdominal aorta, it is invasive and has low sensitivity [3,7]. The width of the contrast column on aortography may underestimate the true aortic diameter if there is significant mural thrombus obscuring the luminal contour of the aneurysm or if the 2-D image acquisition plane is not orthogonal to the plane of maximum aortic diameter. Aortography is the main diagnostic component of endovascular AAA interventions and may be particularly useful in emergent cases of ruptured AAA.

Variant 1: Pulsatile abdominal mass, suspected abdominal aortic aneurysm. Initial imaging. B. CT Abdomen and Pelvis

CT abdomen and pelvis with intravenous (IV) contrast, CT abdomen and pelvis without and with IV contrast, and CT abdomen and pelvis without IV contrast are noninvasive, fast, and commonly used to evaluate various abdominopelvic pathologies, including aortic and nonaortic causes of a pulsatile abdominal mass.

There is no specific literature regarding aortic measurements on standard CT images, with or without IV contrast, for the initial imaging evaluation of suspected AAA; however, aortic diameters can be accurately assessed on CT images if the abdominal aortic contour is well visualized and can be distinguished from adjacent structures. AAAs can be incidentally diagnosed on both contrast- and noncontrast-enhanced CT scans performed for various other clinical indications [4,5,21-23].

In determining maximum aortic diameter on CT, the OTO aortic diameter perpendicular to the long axis of the aorta is recommended [7]. This is obligatory for noncontrast CT images in which the aortic wall and lumen cannot be distinguished. Noncontrast CT has been found to be more sensitive than ultrasound (US) in identifying AAAs [24].

Variant 1: Pulsatile abdominal mass, suspected abdominal aortic aneurysm. Initial imaging. C. CTA Abdomen and Pelvis

CTA abdomen and pelvis with IV contrast and CTA abdomen and pelvis without and with IV contrast provide rapid image acquisition of submillimeter, isotropic, 3-D data sets of the aorta and its branch vessels with high spatial resolution [25-27]. Measurement of the maximal aortic diameter based on the OTO wall diameter perpendicular to the long axis of the aorta on CTA is considered the reference standard for AAA diagnosis and management decision making [7].

CTA is also the imaging procedure of choice for preoperative assessment before endovascular or open surgical repair [10,13,26,28]. The scan range should include the iliofemoral arteries to evaluate the access vessels and also the chest in patients with thoracoabdominal AAA.

CT, preferably CTA, is recommended for evaluation of symptomatic patients who present with acute onset abdominal or back pain, particularly in the presence of a pulsatile abdominal mass or significant risk factors for AAA [7]. Whether CTA should be the initial imaging modality used for evaluation of asymptomatic patients suspected to have an AAA is less clear.

Dual-energy CTA, which allows for simultaneous acquisition of CT data with 2 different photon energy spectra, can be used to characterize AAAs with reduced IV iodinated contrast dose without compromising imaging quality [29,30].

Variant 1: Pulsatile abdominal mass, suspected abdominal aortic aneurysm. Initial imaging. D. FDG-PET/CT Skull Base to Mid-Thigh

There is no relevant literature supporting the use of fluorine-18-2-fluoro-2-deoxy-D-glucose (FDG)-PET/CT for initial imaging evaluation of suspected AAA. The CT component of PET/CT can be used for the incidental diagnosis of AAA. FDG-PET/CT can play a role in the diagnosis of inflammatory and mycotic aortic aneurysms [10,31,32] and in predicting risk for AAA rupture [33].

Variant 1: Pulsatile abdominal mass, suspected abdominal aortic aneurysm. Initial imaging. E. MRA Abdomen and Pelvis

MR angiography (MRA) abdomen and pelvis with IV contrast and MRA abdomen and pelvis without and with IV contrast are alternatives to CTA for the diagnosis and preintervention evaluation of AAAs [8,10,13,25,27,28]. Limitations of MRA and MRI in general include longer imaging acquisition times and limited ability to characterize aortic wall calcifications.

MRA abdomen and pelvis without IV contrast can also be used for evaluation of suspected AAA. MRA can be performed without gadolinium-based contrast agents (GBCAs) using techniques such as time-of-flight, balanced steady-state free precession, phase-contrast, and quiescent-interval single-shot imaging [34]. Disadvantages of noncontrast-enhanced MRA include longer image acquisition times and increased motion artifacts [34]. Contrast-enhanced MRA is used more commonly than noncontrast-enhanced MRA for imaging evaluation of AAAs.

Ferumoxytol, an ultrasmall superparamagnetic iron oxide particle, is an emerging alternative to GBCAs for contrast-enhanced MRA [35,36]. Ferumoxytol was originally designed as a blood pool contrast agent for MRI and has a longer duration of intravascular signal than GBCAs.

Although the latest recommendations from the International Society for Magnetic Resonance in Medicine are for measurement of ITI aortic wall diameter on double-oblique reformatted images perpendicular to the vessel long-axis for measurement technique, the OTO aortic wall diameter should also be reported in cases of aneurysm or wall thickening if that approach is adopted [37]. The ITI wall measurement method was recommended because of its high conformity to the LTL measurements used in echocardiography, which is a consideration more relevant to the thoracic aorta [25,37]. The Society for Cardiovascular Magnetic Resonance and others advocate measurement of the outer aortic wall contour for aneurysms [38,39].

Variant 1: Pulsatile abdominal mass, suspected abdominal aortic aneurysm. Initial imaging. F. MRI Abdomen and Pelvis

For the initial imaging evaluation of suspected AAA, the considerations for MRI of the abdomen and pelvis without dedicated MRA sequences are similar to that of MRA [8,10,25]. As with CT, a routine MRI abdomen and pelvis with IV contrast or MRI abdomen and pelvis without and with IV

contrast can be used to measure abdominal aortic diameter if the aortic contour is well depicted. Either procedure may also characterize possible nonaortic causes of a pulsatile abdominal mass. AAAs can also be incidentally detected on MRI of the abdomen and pelvis performed for other reasons [5].

Accurate and reproducible aortic diameter measurements, comparable to CTA measurements, can be obtained from MRI without IV contrast by using black-blood sequences acquired with spin-echo techniques [40]. With advanced imaging methods, MRI can also provide functional and hemodynamic data, such as quantification of aortic wall stiffness and blood flow [25].

Variant 1: Pulsatile abdominal mass, suspected abdominal aortic aneurysm. Initial imaging. G. Radiography Abdomen and Pelvis

There is no relevant literature supporting the use of radiography for the initial imaging evaluation of a pulsatile abdominal mass suspected to be an AAA. Radiography is not recommended for initial imaging for suspected AAA because of its low sensitivity for AAA detection [3,7]. AAA can be incidentally discovered on abdominal radiographs obtained for other purposes if aortic wall calcifications are visible and allow for assessment of aortic diameter; however, AAA morphology and extent may not be accurately or fully evaluated [3].
US Aorta Abdomen

Variant 1: Pulsatile abdominal mass, suspected abdominal aortic aneurysm. Initial imaging. H. US Aorta Abdomen

Transabdominal US of the abdominal aorta poses negligible risk to patients and can reliably detect the presence of an AAA in nearly all patients with sensitivity and specificity approaching 100% [3,9,10,16]. With the portability of US machines, sonographic evaluation of the abdominal aorta can be performed in a wide range of settings, including in the emergency department [16,41]. US of the abdominal aorta is the mainstay imaging procedure for AAA screening and surveillance [7,12,16,42,43] and is often the first-line imaging study performed for evaluation of asymptomatic patients suspected to have an AAA [9,10,16,44].

In 1% to 2% of cases, the abdominal aorta cannot be adequately evaluated by US because of large patient body habitus or excessive overlying bowel gas [14,45]. Pre-evaluation overnight fasting is recommended to reduce bowel gas in patients [3,10,16].

There remains debate over the optimal method to measure maximum aortic diameter on US with conflicting data from several studies comparing the accuracy and reproducibility of OTO, ITI, and LTL measurement techniques [16,46-52]. The American Institute of Ultrasound in Medicine recommends measuring the greatest diameter of the abdominal aorta from the OTO edges of the aortic wall [53], whereas the United Kingdom's National Health Services AAA Screening Programme uses the maximal anterior to posterior ITI diameter as the standard measurement parameter for AAA diagnosis [44].

Compared to CT, US underestimates AAA diameters by an average of 1 to 3 mm [15,16,54-56]. For preintervention planning for AAA endovascular or surgical repair, US is insufficiently precise and does not provide imaging information on access vessels and abdominal aortic branches [7,13]. A CTA, or alternatively MRA, is needed when the size threshold for repair is reached [10,13,44].

To overcome variations in imaging plane orientation that can occur with conventional 2-D US, 3-D

US has shown promise for improved accuracy and reproducibility in aortic diameter measurements by allowing for measurements to be made in the plane orthogonal to the centerline of the abdominal aorta [57,58].

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

I. US Intravascular Aorta Abdomen

Intravascular US of the abdominal aorta provides accurate and reproducible measurements of aortic diameter and length [59,60]. It is, however, an invasive procedure that does not have a significant role in the initial diagnosis of AAAs. Intravascular US is commonly used during endovascular AAA repair procedures for stent-graft sizing and treatment planning [60].

Summary of Highlights

- **Variant 1:** US of the abdominal aorta, CTA of the abdomen and pelvis with IV contrast, CTA of the abdomen and pelvis without and with IV contrast, MRA of the abdomen and pelvis with IV contrast, MRA of the abdomen and pelvis without and with IV contrast, or MRA abdomen and pelvis without IV contrast is usually appropriate for initial imaging in a patient who is suspected to have an AAA. In this variant, these procedures are generally equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care).

Supporting Documents

The evidence table, literature search, and appendix for this topic are available at https://acsearch.acr.org/list. The appendix includes the strength of evidence assessment and the final rating round tabulations for each recommendation.

For additional information on the Appropriateness Criteria methodology and other supporting documents, please go to the ACR website at https://www.acr.org/Clinical-Resources/Clinical-Tools-and-Reference/Appropriateness-Criteria.

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, because of both 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 with 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
O	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 (e.g., region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as “Varies.”

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Disclaimer

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.

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