



Aortic Aneurysms

- Abdominal aneurysm size can be measured with ultrasound imaging in most patients; thoracic aortic aneurysm size is best measured with CT
- Patients with thoracic aneurysm diameter >6 cm and abdominal aneurysms diameter > 5 cm are referred for evaluation for aneurysm repair
- CT angiography with three dimensional reconstruction is performed for pre-operative assessment prior to aneurysm repair and for follow-up imaging after endovascular repair
- One time ultrasound screening for abdominal aortic aneurysms is recommended for those who are at high risk



Figure 1. Abdominal aortic aneurysm. Intravenous contrast enhanced CT images of the abdominal aorta demonstrates an aneurysm measuring 5.4 cm in diameter. Axial images (A) demonstrate intraluminal thrombus (arrow). The 3-D reconstruction images (B) demonstrates that the aneurysm extends from the level of the renal arteries (solid arrow) to the iliac bifurcation (dashed arrow).

Abdominal aortic aneurysms (AAAs) cause 1.3% of deaths among men aged 65-85 years in developed countries, resulting in approximately 15,000 deaths per year in the United States. The prevalence of abdominal aortic aneurysms 3-5 cm in diameter is 1.3% in men aged 45-54 and 12.5% in men aged 75-84. In comparison, the prevalence in women is 0%

and 5.2% respectively. Prevalence varies by race and AAAs are very rare in Asians. In comparison, thoracic aortic aneurysms (TAAs) cause about 0.01% of deaths, which are equally distributed between women and men. Risk factors that increase the likelihood of aneurysms include family history, smoking, and hypertension.

Aortic aneurysms are defined as dilatations of ≥ 3 cm diameter. Most are asymptomatic and are found incidentally on routine physical examination or radiologic examinations conducted for another purpose. Some are seen with plain film radiography, which can detect AAAs if calcification is present, whereas TAAs can appear as a widening of the mediastinal silhouette, enlargement of the aortic knob, or tracheal deviation. However, plain films do not detect all aneurysms and is not suitable for measuring the size of an aneurysm. Other aortic aneurysms are incidentally detected by ultrasound, CT, MRI, or nuclear medicine scans.

In addition to incidental findings, some AAAs are found by screening, which has been recommended as one time ultrasound examinations of patients at risk because of the prevalence of AAAs and the serious consequences of their rupture.

Indications for Imaging for Abdominal Aortic Aneurysm

1. Screening

Men ≥ 65 -75 years who have ever smoked

Men ≥ 60 years with sibling or parent with AAA

Women ≥ 65 years with cardiovascular risk factor

Both men and women >50 years with family history of aneurysmal disease

2. Diagnostic

Palpable pulsatile abdominal mass

Unexplained lower back or abdominal pain

Known aneurysmal disease in extremities

Follow-up of previously demonstrated abdominal aortic aneurysm

Follow-up of patients with aortic or iliac endoluminal graft

Indications for Referral to a Vascular Specialist

AAA ≥ 5.0 cm

TAA ≥ 6.0 cm

Aneurysm expansion ≥ 0.5 cm in one year

Diagnostic Imaging

If an aneurysm is incidentally detected by CT or MRI, no further imaging is required for evaluation. Ultrasound is recommended for measuring AAAs detected by standard radiography because ultrasound is accurate, less expensive than other imaging modalities, and avoids exposure to ionizing radiation. Accuracy is estimated to be within 3 mm for longitudinal, anterior-posterior, and transverse direction. However, sensitivity of ultrasound is limited by bowel gas and body habitus and is estimated to be 92-99% with a specificity of 100%.

CT without contrast is recommended for measuring the overall dimensions of TAAs. Three-dimensional (3-D) reconstruction is necessary to accurately measure the diameter of aneurysms because cross-sectional imaging may exaggerate the size of an aneurysm in a tortuous aorta, especially in the thorax. CT with intravenous contrast provides more detail because it can be used to measure thickness of the aortic wall outside of calcified deposits, detect bleeding within a thrombus, and demonstrate the presence of para-aortic fibrosis. Therefore, unless contra-indicated, contrast-enhanced CT is generally performed.

Surveillance

The annual risk of AAA rupture for aneurysms <4 cm in diameter is zero, while the risk increases to 3-15% for those that are 5.0-5.9 cm in diameter. The risk of rupture in women with AAAs of 4.0-5.5 cm is four times greater than that for men, perhaps because they have smaller aortas than men. In the thorax, the annual risk of rupture is 3% at 5.0-5.9% diameter, increasing to 7% for TAAs ≥ 6 cm.

Evidence from clinical trials indicates that surveillance of AAAs that are less than 5.5 cm is both safe and cost-effective. The intervals between imaging examinations are shorter for larger aneurysms because growth rates tend to be greater as the diameter of AAAs increase. In addition, smoking increases growth rate of AAAs by 15-20% and growth rates are higher in patients with low body mass index (BMI), whereas diabetes decreases growth by $>30\%$. Based on large surveillance studies of growth rates, optimal surveillance intervals between ultrasound examinations for AAAs have been calculated. If these intervals are followed, no more than 1% of patients are predicted to have an aneurysm exceeding 5.5 cm at the time of examination, the size at which repair is recommended. Surveillance imaging for known TAAs is recommended at 6-12 month intervals.

Optimal Surveillance Intervals for Abdominal Aortic Aneurysm*

Aneurysm diameter	Screening Interval
3.5 cm	36 months
4.0 cm	24 months
4.5 cm	12 months
5.0 cm	3 months

*From Brady et al., 2004. Recommendations restrict probability of breaching the 5.5 cm limit to $<1\%$.

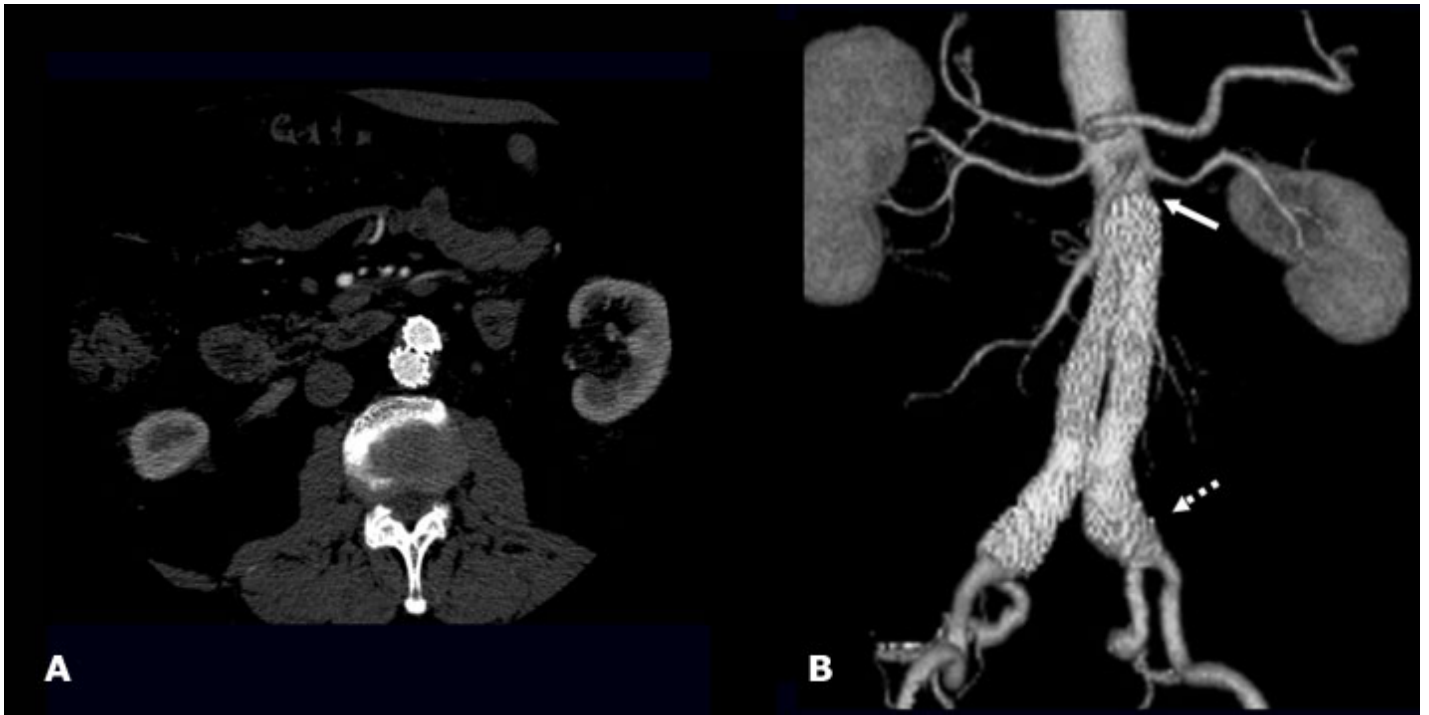


Figure 2. Endovascular stent. Axial (A) and 3-D reconstruction (B) CT images with intravenous contrast demonstrates a endoluminal stent originating at the level of the renal arteries (solid arrow), bifurcating into two limbs that terminate in the internal iliac arteries (dashed arrow)

CTA and MRA

If an AAA is ≥ 5 cm or a TAA is ≥ 6 cm, CT angiography (CTA) is indicated to demonstrate the three dimensional anatomy of the aneurysm and its relationship to branch vessels, which is needed to help determine whether endovascular or open surgical repair is preferable. Catheter based angiography is seldom used in surgical planning because it is more invasive than CTA and is not suitable for 3-D reconstruction. If nephrotoxicity of CT contrast agents is a concern, MR angiography (MRA) is an alternate imaging modality; but the images are of lower resolution and the relatively large quantities of gadolinium contrast used does not completely eliminate the concern for nephrotoxicity. Reconstruction of CTA or MRA images into 3-D images allows examination of the precise anatomy of the aneurysm, which can be examined from all angles. These images aid selection of the most suitable stent graft device and can be used to simulate insertion of a device.

Stent graft devices are used at the MGH in about 70% of AAAs and 40-50% of TAAs. The success rate for intra-luminal stent graft placement for aortic aneurysms is high at MGH, with $< 1\%$ requiring conversion to surgical repair. CT is recommended for patients following intervention at 6 months, 1 year, and annually thereafter. CT follow up is required by the FDA for some devices.

Scheduling

MRI, CT or US for diagnosis and evaluation of aortic aneurysms may be ordered through ROE for appointments at the MGH Main Campus, Mass General West Imaging Waltham, and MGH Chelsea Health Center, or by telephone 617-724-XRAY (9729) for all locations.

Further Information

For further questions, please contact [Alan Greenfield, M.D.](#), Cardiovascular Radiologist at 617-726-8788.

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