

# Imaging Guidelines for Abdominal Aortic Aneurysm Repair with Endovascular Stent Grafts

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ACCURATE, high-quality and standardized imaging interpreted by well trained observers is essential for the successful screening, staging and treatment of abdominal aortic aneurysms (AAAs) with endovascular stent grafts. The optimal imaging modalities and protocols vary for preprocedural, intraprocedural, and postprocedural issues. They may also vary for any given patient. However, the goal of this document is to recommend imaging modality and protocol preferences for the majority of patients being considered for this technology.

The current imaging modalities that have been successfully used in this technology are fluoroscopy, plain radiography, computed tomography (CT), ultrasonography (US), intravas-

cular US, and magnetic resonance imaging, and catheter angiography. No single one of these modalities can adequately address all the questions that need to be answered when attempting to care for the patient. Each modality has its own strengths and weaknesses. The preferential utilization of these modalities in any given case should consider issues of relative cost, radiation exposure risk, invasiveness, contrast necessity and tolerance, availability, reproducibility, ease of interpretation and performance in all patients. Also, the imaging modalities should be applicable to all the current device designs.

With this in mind, the following recommendations are made:

**Preprocedural imaging.** The goals of preprocedural imaging are:

- I. To detect or confirm the detection of the AAA.
- II. To stage the AAA. Staging questions that need to be answered are:
  - a) the maximal diameter and length of the AAA and its lumen;
  - b) the diameter, length and angulation of the proximal landing zone;
  - c) the diameters, lengths and angulation of all the distal landing zones;
  - d) the diameter and angulation of the potential access routes;
  - e) the total length of territory to be covered;
  - f) the distance from the lowest renal artery to the aortic bifurcation;

- g) the distance from the lowest renal artery to each iliac bifurcation;
- h) the diameter of the aortic bifurcation;
- i) relative location and extent of the AAA (where does it start and where does it stop in relationship to major branches and bifurcations);
- j) presence of and location of thrombus in the AAA;
- k) presence of rupture of the AAA or coexistent periaortic pathology (inflammatory AAA);
- l) presence and location of coexistent aneurysmal disease (iliac, femoral, visceral);
- m) presence and location of coexistent iliofemoral occlusive disease;
- n) number and types of patent branches arising from the aneurysm sac;
- o) patency and location of the SMA, IMA and celiac;
- p) quality of landing zones and potential access routes (calcification, atheroma);
- q) presence of vascular anomalies (multiple renal arteries, early bifurcations, venous anomalies).

Two imaging modalities performed no more than 6 months prior to the planned procedure are recommended to achieve the above goals:

## Thin-Cut Helical/Spiral CT Arteriography (CTA) with Multiplanar Reconstruction

Although thin-cut (less than 3 mm) conventional dynamic CT scanning

These guidelines were developed at the request of the U.S. Food and Drug Administration on January 28, 2000. A more comprehensive document is being developed for future publication.

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may be adequate, helical/spiral scanning is preferable. Different CT scan manufacturers have slightly different protocols to achieve the same result with the following common features:

1. A localizing scan should be performed first. This scan
  - a) requires no oral and no intravenous contrast; Should be performed from the diaphragm to mid intertrochanteric region;
  - b) if done in helical/spiral mode can have 10-mm collimation, 2.0 pitch, 80–100 KV, 90–100 mA;
  - c) should be used to localize the celiac origin level and femoral bifurcations. It is also useful to assess calcification and general issues.
2. A CTA scan should then be performed. This scan
  - a) should be a helical/spiral scan from celiac origin to the femoral bifurcation preferably in one or two breath holds. Total scan time should be about 40–50 seconds;
  - b) should use 3-mm (or less) collimation, 2.0 pitch; 120 KV, 280 MA, 750-msec gantry rotation;
  - c) should have a volume of 120–200 mL of low osmolar contrast administered via large bore (18-gauge) antecubital vein at 2–5 mL/sec with either a timed delay or a 20–30-second delay depending on estimated circulation time.
3. A reconstruction series (2 mm or less) can then be constructed from the above scan that includes the total table travel distance (usually 33–42 cm) and smaller FOV centered on aorta (18–20 cm). Most of all the quantitative measurement and much of the qualitative information can be obtained from this data. This series needs to be evaluated on a workstation capable of multiplanar reformation.

### Catheter Angiography

Catheter angiography performed with a calibrated marker catheter that has radio-opaque marks every 1–5 cm over at least a 20-cm segment is recommended. The angiogram should encompass the abdominal aorta from

the celiac axis to the femoral bifurcations. The abdominal aorta should be imaged in at least two views (90 degrees apart, AP and lateral preferably). A view including the renal arteries to the iliac bifurcations on one image should be included in this series. The pelvic (iliofemoral) segment should be imaged in at least three views (AP, RAO, LAO) with the catheter positioned in the lower abdominal aorta. Digital imaging with or without subtraction or cut-film imaging is adequate. Additional appropriate views to ensure visualization of branch origins are necessary.

The combination of CTA and catheter angiography as performed above should be sufficient pretreatment imaging evaluation in the vast majority of patients. If an individual patient has contraindications to iodinated contrast, then a gadolinium-enhanced MRA combined with a noncontrast thin-cut CT or intravascular US may be sufficient to answer preprocedural imaging questions.

**Intraprocedural imaging.** The goals of intraprocedural imaging are as follows:

- I. To guide and document the appropriate placement of the endovascular stent graft.
- II. To evaluate the effectiveness of the stent graft in excluding the AAA.

**Fluoroscopy and catheter angiography** are the imaging modalities that should be necessary and sufficient in the vast majority of cases.

The minimal fluoroscopy unit requirements for placement of endovascular stent grafts are to have a unit that is capable of complex angulation (C-arm) and has an image intensifier (I-I) with a field of view large enough to cover the area of interest (minimum 9 inch; optimally larger) without moving. The unit needs to have the capacity to adequately penetrate the area of interest. The operator should be trained in techniques of radiation protection, and total fluoroscopy time should be recorded. Catheter angiography, with the ability to record and interpret serial images (digitally, videotape, film), is also an intrinsic component of the procedure. Intravascular US may rarely be helpful in the assessment and evaluation of endoleaks or graft patency.

**Postprocedural imaging.** The goals of postprocedural imaging are:

- I. To confirm and redocument the appropriate placement of the stent graft.
- II. To better assess the effectiveness of the stent graft in initially excluding the AAA (detecting flow in the sac).
- III. To follow the long-term fate and size of the AAA sac and ensure its stability.
- IV. To detect remote stent graft failure (structural or functional).
- V. To better characterize and possibly treat any endoleaks.

At present the imaging modalities best utilized to achieved the above goals are:

**Plain films of the abdomen** (four views, AP, lateral and oblique). These images are most helpful for evaluating the metallic components of these devices. As the aneurysm shrinks, there are structural changes that may occur in these components (the significance of which is not clear). Migration, angulation, kinking and breakage are the findings to look for. A baseline series of plain films should be obtained after discharge and then every 6 months for at least 2 years.

**CTA.** The protocols for CTA are similar to those for the preprocedural imaging. However, the focus of postprocedural CTA is primarily to document AAA sizing and to search for the presence of endoleaks. In light of the desire to evaluate for endoleaks, an additional delayed series obtained greater than one minute after the dynamic contrast scan is recommended. An initial baseline (less than 1 month) CTA should be obtained. If no problems with the device are apparent, then scans should be repeated every 6 months for 2 years and then yearly thereafter. If a problem is apparent (endoleaks, AAA size increases) or symptoms occur, more frequent imaging may be required.

**Catheter angiography.** Catheter angiography may be helpful in better characterizing and treating any endoleaks that have been detected. There is no need to have a catheter angiogram in those patients with satisfactory outcomes suggested by CTA.