



**PHYSICIAN**  
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## PREOPERATIVE IMAGING WORK-UP

### COMPUTED TOMOGRAPHY

Spiral computed tomography contrast-enhanced scan is the standard preoperative imaging modality for endovascular aneurysm repair (EVAR). A high-quality scan can be reconstructed on a three-dimensional (3D) base.

### AAA PROTOCOL

- An initial run without contrast would be useful to evaluate calcification of the vessels.
- The patient will receive between 100 mL to 200 mL iodinated contrast agent intravenously.
- Oral contrast should be avoided to minimize artifacts, especially with 3D reconstruction.
- Collimation should be narrowed to 2.5-mm to 5-mm intervals.
- The scan should study the area between the celiac artery and the level of the common femoral artery bifurcation.
- Suspended respiration during acquisition. Run the table at 5 mm/s.

### ANGIOGRAPHY

In the vast majority of cases, high-resolution CT scan imaging should be sufficient for thorough evaluation of the anatomy and accurate graft selection. On rare occasions, preoperative angiography may be beneficial, however, this can always be done at the time of EVAR. Preoperative angiography may be beneficial for inexperienced operators.

### MAGNETIC RESONANCE ANGIOGRAPHY

Magnetic resonance angiography is an alternative diagnostic modality to CT scan, with the following advantages:

- In the presence of renal insufficiency, it can eliminate the use of nephrotoxic contrast agents.
- It eliminates the use of iodinated radiation.
- It can also generate 3D reconstruction.

## ENDOVASCULAR ANEURYSM REPAIR (EVAR)

### REQUIRED IMAGING EQUIPMENT FOR EVAR

The vast majority of EVAR procedures are currently performed in an operating room using a portable C-arm digital fluoroscope with subtraction capabilities. Although the need to change the gantry is not as frequent as in carotid stenting, it is nice to have a C-arm that is motorized. Obviously, a fixed system will work even better. Because it is occasionally necessary to visualize the renal artery as well as the internal iliac artery simultaneously, it is useful to have a large image intensifier (12 inch or 16 inch).

### TECHNIQUES TO OBTAIN VASCULAR ACCESS

Most currently available devices require surgical exposure and an arteriotomy due to the large profiles of the introducer systems (18 F to 23 F). The incision is placed close to the inguinal ligament and retraction of/or partial division of the inguinal ligament may be necessary to dissect the external iliac artery. After arterial exposure, an 18-gauge, one-wall needle is used to puncture the artery, and a .035-inch guidewire is inserted through the needle. The needle is then removed, and an introducer sheath (7-9 F, 10-25 cm long) is inserted over the guidewire.

Alternatively, one can perform EVAR percutaneously. Although no closure device is designed for closure of puncture sites as large as that of the EVAR delivery system, by deploying the closure device prior to introduction of the endograft, closure can be achieved with reasonable success rates in select patients with healthy femoral arteries.

### AORTOGRAM

A marker pigtail catheter (with measurement markers) is inserted into the abdominal aorta for initial aortography. The pigtail catheter should be introduced from the contralateral side to the main endograft deployment. The aortogram is best obtained with a contrast injector, which should be set at 15 mL to 20 mL of contrast injected at 15 mL/s. Although most important information can be obtained from a good-quality CT scan, angiographic confirmation of the proximal and distal neck diameter, as well as the length, is helpful.

### COIL EMBOLIZATION OF THE INTERNAL ILIAC ARTERY

If the common iliac arteries are aneurysmal and lack an adequate landing zone, it may be possible to extend the limb into the external iliac artery. It has generally been believed that bilateral internal iliac artery occlusion carries the risk of

colonic and/or pelvic ischemia. However, if this cannot be avoided, it can be performed with a relatively low complication rate, with the exception of buttock claudication. Coil embolization can be performed at the time of EVAR, or it can be staged. If the external iliac artery is tortuous, selective cannulation of the internal iliac artery may be best done via a contralateral approach.

### DELIVERY OF THE ENDOGRAFT

An exchange catheter is used to introduce a super-stiff wire. This is performed to straighten any tortuosity in the access vessel and to improve trackability of the endograft. One must be cognizant of where the tip of the stiff wire is because, occasionally, the guidewire will engage the carotid artery. Also, sudden onset of cardiac arrhythmia is a common sign of the wire being placed in the heart.

After the proper dosing of intravenous heparin (10 units/kg), the endograft delivery system is introduced without creating an arteriotomy. In diseased femorals, it may be best to create an arteriotomy. Difficulty in endograft delivery may be encountered if the iliac artery is diseased or small. In such cases, balloon angioplasty of the lesion may be helpful. Stenting should be performed at the completion of EVAR because inserting the endograft may dislodge the stent. If the difficulty is related to tortuosity, the stiffest guidewire available should be used. Also, the "push-and-pull" technique may be useful, which is done by simultaneously pulling on the super-stiff wire while introducing the endograft. Having maximum purchase of wire should help perform this maneuver. Alternatively, the tortuous vessel may be stabilized by applying external pressure onto the access vessel or the aneurysm. Finally, a limited retroperitoneal exposure of the common iliac artery may be made to bypass the diseased external iliac artery. Make sure that the diameter of the conduit is large enough for the endograft being used.

### DEPLOYMENT OF THE ENDOGRAFT

Once the introducer sheath is advanced to the proximal neck of the AAA, an angiogram is obtained via the pigtail catheter inserted from the contralateral side to identify the location of the lowest renal artery. It is important to magnify the image and also to place the renal artery in the center of the image intensifier to minimize parallax. Also, if there is any anterior-posterior angulation to the proximal neck, the image intensifier should be positioned appropriately (perpendicular to the neck). Each endograft type has a unique

# ABDOMINAL AORTIC INTERVENTIONS

deployment mechanism, and one should refer to the manufacturer's "instructions for use" for individual details.

## DEPLOYMENT OF THE WIRELESS PRESSURE SENSOR

The wireless implantable pressure sensor was developed to detect endoleaks and has recently been approved by the FDA. The sensor should be implanted from the contralateral femoral artery prior to deployment of the main body. After deployment of the main body, the sensor is unsheathed from the delivery sheath and is kept in position (inside the sac) with the tether wire. The delivery sheath is removed from the femoral artery while the tether wire remains inside the femoral artery. One can then proceed to the deployment of the contralateral limb.

## DEPLOYMENT OF THE CONTRALATERAL LIMB

For modular endografts, it is necessary to deploy the contralateral iliac limb. A 7-F sheath (25 cm) should be introduced into the aneurysm sac to straighten the iliac artery such that the directional catheter can be better controlled. In general, a single curved catheter is sufficient. For better torque control as well as maneuverability, an angled hydrophilic guidewire should be used. Alternative approaches include the contralateral up-and-over technique and the brachial approach. With the contralateral approach, a curved catheter is placed at the flow divider, followed by the placement of a wire into the sac. A snare is introduced into the sac from the contralateral femoral artery, and the previously placed guidewire is snared.

Once cannulation has been accomplished, it is important to confirm that the guidewire is located within the endograft and not outside (in between the proximal stent and the aortic wall). A pigtail catheter is introduced over the guidewire and a "spinning test" is then performed within the proximal stent.

The next step is to deploy the contralateral limb. A final confirmation of the length, as well as diameter should be made with an angiogram. The marker pigtail can be used to measure the distance between the short limb and the hypogastric artery. When obtaining this angiogram, it is important to obtain the appropriate oblique view to visualize the orifice of the internal iliac artery (contralateral oblique).

In cases in which the common iliac is large, one can use the "bell bottom" technique, which is done by deploying an

oversized proximal extension cuff at the distal attachment site. In doing so, one needs to terminate the first limb 3 to 4 cm above the landing zone because the second oversized stent needs some room for it to flare out.

## TOUCH-UP BALLOONING OF THE ENDOGRAFT

Although all the stents are self-expanding, most "instructions for users" recommend the performance of a "touch-up" balloon. This maneuver is performed at both the proximal as well as the distal attachment sites. Also, any junction of the modular components should be touched up. It is important to use a compliant balloon and to avoid high-pressure dilatation that may damage the endograft.

## COMPLETION ANGIOGRAPHY

A completion angiogram should be obtained with a power injector. It is important to visualize the early phase, as well as the late phase, in which one can detect subtle endoleaks. If a wireless pressure sensor is being used, it is released from the tether wire at this point. Low sac pressure will confirm satisfactory exclusion of the sac, whereas high pressure may indicate further angiographic evaluation. All the sheaths and wires are removed, and the femoral arteriotomy is then closed with running sutures. In cases in which the femoral artery is small or diseased, a patch closure of the arteriotomy may be performed. One needs to rule out possible iliac dissection caused by the introduction of a large delivery system. Because distal embolization can occur, it is important to check the presence of distal pulses and compare it with the preoperative condition.

## FOLLOW-UP

There is no specific medical therapy needed after EVAR. Enhanced CT scan and abdominal radiographs should be obtained at 1, 6, and 12 months postoperatively, and yearly thereafter. Wireless sac pressure monitoring can be done more frequently and should be customized depending on various risk factors, including the size of the AAA and the length and diameter of the proximal neck. ■