Preservation of Internal Iliac Arterial Flow during Endovascular Aortic Aneurysm Repair Using the “Sandwich” Technique

Mitchell T. Smith, MD, MS¹ Rajan Gupta, MD¹ Omid Jazaeri, MD¹ Paul J. Rochon, MD¹
Charles E. Ray, Jr., MD, PhD, FSIR¹

¹ Department of Radiology, University of Colorado, Denver Anschutz Medical Campus, Aurora, Colorado

Semin Intervent Radiol 2013;30:82–86

Address for correspondence Charles E. Ray, Jr., MD, PhD, FSIR, Department of Radiology, University of Colorado, Denver Anschutz Medical Campus, Stop L954, 12401 E. 17th Avenue, Room 526, Aurora, CO 80045 (e-mail: Charles.ray@ucdenver.edu).

Conventional endovascular aneurysm repair (EVAR) of an abdominal aortic aneurysm (AAA) requires adequate graft seal proximally in the infrarenal aorta and distally in the common or external iliac arteries. When possible, sealing in the common iliac artery is performed to maintain perfusion to the internal iliac artery. Approximately 40% of AAAs have associated common iliac artery aneurysms that would require an external iliac seal zone and ipsilateral internal iliac artery embolization to prevent a type II endoleak. Concurrent or staged internal iliac artery occlusion may result in pelvic ischemia, which commonly manifests as buttock claudication or, in men, impotence. Uncommon but more serious consequences include colonic and spinal artery ischemia. Coverage or embolization of a single internal iliac artery is generally well tolerated. There is a varied incidence (20 to 50%) of clinically significant buttock claudication that tends to improve over time resulting in ~10% incidence of buttock claudication at 1 year with single hypogastric artery embolization.

Published case series and individual reports of bilateral internal iliac artery embolization demonstrate that bilateral hypogastric occlusion appears safe, although there is an increased risk of serious complications that may be life threatening. Most physicians attempt to preserve flow to a single internal iliac artery whenever possible. Various methods have been described to preserve internal iliac artery flow during EVAR. Investigational iliac branched devices (not currently approved by the Food and Drug Administration [FDA]), hybrid surgical revascularization of the internal iliac artery, physician modification of existing endografts, and, more recently, parallel endografting with the “sandwich” technique are some of the ways flow can be preserved to the hypogastric artery.

The sandwich endograft technique involves placing two endografts side by side into an existing iliac limb to create an off-the-shelf bifurcated component to preserve flow to both

the internal iliac and external iliac arteries. This technique has been gaining acceptance as a viable method for preservation of flow to at least a single internal iliac artery allowing for expansion of anatomy suitable for EVAR with the use of commercially available endograft components, albeit in an off-label manner. The sandwich technique is applicable to a variety of endograft designs, although the steep bifurcation of most endografts requires axillary or brachial artery access to deliver a stent into the preserved internal iliac artery. The bifurcation-sparing nature of the Endologix AFX (Endologix, Irvine, CA) endograft allows for this technique to be performed from an entirely femoral approach and has become our preferred approach for internal iliac preservation during EVAR when the anatomy is appropriate.

Sandwich Endograft Concept

The sandwich technique involves placing two parallel endografts within an existing iliac limb to create an off-the-shelf bifurcated iliac component. With this approach, there is an inherent risk of a type III endoleak from the “gutters” created between sandwich endograft components, although with appropriate sizing persistent endoleaks are uncommon. To minimize the guttering phenomenon, the combined cross-sectional area of the sandwich endografts must be greater than the cross-sectional area of the iliac limb. In our practice, we size the cross-sectional area of the two component 30% greater than the cross-sectional diameter of the iliac limb. Overlap of the components across a longer area is also recommended to decrease the risk of a type III endoleak. With most conventional endografts, the steep bifurcation requires delivery of the hypogastric endograft from either brachial or axillary access. The unique bifurcation-sparing aspect of the Endologix AFX endograft allows for a femoral-only approach to hypogastric artery preservation. The Endologix AFX iliac limb extension is sized to the main body limb,

and the Viabahn (Gore, Flagstaff, AZ) hypogastric endograft is appropriately sized to the internal iliac artery. This technique is typically performed with the 16-mm diameter AFX main body limb of the longest length that will allow sufficient room for hypogastric cannulation. A detailed description of the deployment sequence with the AFX device is described below.

Preprocedure

Patient selection based on vascular anatomy is critical for successful internal iliac preservation. All patients receive a high-resolution preprocedure contrast-enhanced computed tomography (CT) scan to evaluate proximal and distal landing zones, aneurysm morphology, iliac artery anatomy, and femoral access. An adequate seal zone (>10 mm) of non-aneurysmal internal iliac artery must be present for adequate internal iliac artery preservation. Routine laboratories are drawn the day of the procedure to ensure the international normalized ratio (INR) is <1.5 and the platelet count is >50,000/dL; these values are corrected as necessary with fresh-frozen plasma and platelets. Routine serum creatinine is also evaluated to estimate the type and volume of contrast to be used (Iohexal [Omnipaque], Iodixanol [Visipaque], or carbon dioxide [CO₂]). Most of our cases are done under general anesthesia given the increased complexity of the sandwich procedure, although locoregional anesthesia has also been used.

Procedure

Access

Our current preferred approach to EVAR is completely percutaneous when the femoral artery size and anatomy permit. Arterial access to the common femoral arteries is obtained using a combination of fluoroscopic landmarks and ultrasound with micropuncture technique. Ultrasound is used to evaluate the common femoral artery to ensure access in an area of minimal anterior calcification and >5-mm diameter. Prior to percutaneous puncture, a small incision is made in the skin, and blunt dissection is performed to the common femoral artery. The blunt dissection helps to ensure that the ProGlide (Abbott, Abbott Park, IL) suture knots will slide through the tract without obstruction to close the arteriotomy at the conclusion of the procedure.

After a single-wall puncture using ultrasound guidance and a micropuncture needle, a 0.018-inch wire is used to place a 5F transitional dilator. Preclosure is performed with two ProGlide sutures per side after dilation using the dilator from a 9F sheath. ProGlide sutures are deployed in 45-degree right anterior oblique and 45-degree left anterior oblique projections. After suture harvesting, the sutures are secured with hemostats with rubber shoes and placed medial and lateral to the skin incision. Following preclosure, 9F sheaths are placed in the common femoral arteries. The 9F sheath size allows for intravascular ultrasound of the aneurysm and ipsilateral iliac artery to confirm anatomy and sizing. At this point an intravenous heparin bolus is administered (80 to 100 units/kg), and intermittent activated clotting times

(ACTs) are monitored throughout the case. Additional heparin is administered to keep the ACT >250 or 2.5 times normal.

Main Graft Deployment

Given adequate preprocedural planning, the Endologix AFX (Endologix, Irvine, CA) main body can be deployed without using contrast, although an angiographic run may be needed to confirm anatomy (►Fig. 1A). The 17F hydrophilic AFX main body sheath is placed over an extra-stiff 0.035-inch wire (Lunderquist; Cook, Bloomington, IN), which has been placed in the thoracic aorta ipsilateral to the planned preserved hypogastric artery. A vascular snare is placed through the contralateral 9F sheath and into the abdominal aorta.

The Endologix SurePass wire (a hydrophilic wire attached to a hollow core wire) is placed through the 17F sheath into the aneurysmal aorta, where it is snared and brought out the contralateral 9F sheath. As the main graft body is advanced into the aorta, the SurePass wire is retracted through the contralateral sheath (►Fig. 1B). When the device is in the iliac artery, redundancy of the SurePass wire is reduced in a conventional manner for this device. The device is then advanced into the aorta and unsheathed so that both iliac limbs are free. The device is then rotated into orientation and anatomically fixed on the iliac bifurcation. A 300-cm, 0.018-inch wire (Grand Slam; Abbott, Abbott Park, IL) is placed through the hollow core portion of the SurePass wire into the thoracic aorta. The main body and ipsilateral limb are deployed under fluoroscopic guidance (►Fig. 1C). The 17F sheath is readvanced into the main body of the device to provide counter tension during deployment of the contralateral limb. The contralateral limb is then deployed by pinning and pulling the SurePass wire leaving the 0.018-inch wire in place. The 0.018-inch wire is then exchanged for a 0.035-inch stiff wire (Lunderquist) using an angled catheter.

A unique feature of the Endologix endograft is the presence of an endoskeleton. This has particular importance in the snorkel procedure, given that a snorkel stent should not be inadvertently placed through the endoskeleton interstices (►Fig. 1D). At this point, the main body of the endograft is seated on the iliac bifurcation and two stiff 0.035-inch wires are in the thoracic aorta through the true graft lumen and not through the endoskeleton interstices. If patient anatomy requires a suprarenal or infrarenal fixation component, it can be placed ipsilateral to the main body delivery and molded using a semicompliant balloon.

Snorkel Placement

The final steps involve the snorkel and iliac limb placement. The existing contralateral 9F sheath is exchanged for an 18F DrySeal Sheath (Gore, Flagstaff, AZ). Through-and-through access from the AFX sheath to the DrySeal Sheath is obtained with care taken to ensure this wire is through the graft lumen and not through the graft interstices. A vascular snare is placed through the DrySeal Sheath and used to snare a Glidewire (Boston Scientific, Boston, MA) placed through the AFX sheath up and over the bifurcation (►Fig. 1E). The Glidewire is then exchanged for a stiff 0.035-inch Amplatz wire. To ensure access is through the main graft lumen and

Figure 1 (A) Distal aortogram with pelvic runoff demonstrating aneurysmal common iliac arteries, an occluded left internal iliac artery, and a focal aneurysm of the right internal iliac artery (arrow). (B) After placement of the ipsilateral Endologix AFX sheath and the contralateral 9F sheath, the graft is extended through the AFX sheath. The SurePass wire (arrow) is seen extending from the graft and out the contralateral 9F sheath. (C) The graft is seated onto the aortic bifurcation prior to deployment. (D) Endoskeleton of AFX endograft. Note how it is possible to inadvertently cross between the graft fabric and interstices of the metallic endoskeleton. (E) Placement of two wires into the thoracic aorta and an 18F DrySeal Sheath placed into the left common femoral artery. The snare (arrow) will be used to obtain through-and-through access from the common femoral arteries. (F) A coaxially inserted 12F Mullin sheath (arrow) is placed over the through-and-through stiff wire. (G) An angled catheter and Glidewire are used to select the internal iliac artery (arrow). (H) An Amplatz wire is placed into the inferior gluteal artery (arrow). (I) With a marking catheter placed, angiography is performed to confirm the sizes of the Viabahn stent for the internal iliac artery and the extension limb that will span the common iliac to external iliac arteries. (J) The stents are advanced through their respective sheaths and positioned to line up proximally prior to deployment of the AFX component (black arrow) first and the Viabahn second (white arrow). (K) The Endologix component is molded using a semicompliant balloon, and the Viabahn is molded using an angioplasty balloon (arrow). (L) Final angiograms from the Mullin sheath showing preserved internal iliac arterial flow (arrow). (M) Final angiogram from an aortic pigtail catheter showing no evidence of endoleak. (N) Three-dimensional volumetric computed tomography (CT) reconstruction of the graft and the two components. (O) Sagittal CT reconstruction demonstrating the proximal extent of the two snorkel components (large arrows). (P) Axial CT centerline reconstruction demonstrating the larger, medial Endologix component (open arrow) and lateral, smaller Viabahn component (closed arrow) within the aneurysm sac.

Figure 1 (continued)

not the interstices, intravascular ultrasound or a 6- to 8-mm conventional angiography balloon may be passed through the path of the through-and-through wire.

At this point, there should be wire access from the AFX sheath to the DrySeal Sheath, as well as wires extending through the CFA sheaths and into the thoracic aorta. A 12F Mullin sheath (Cook, Bloomington, IN) is placed through the DrySeal Sheath over the through-and-through wire and into

the contralateral common iliac artery below the ipsilateral limb (►Fig. 1F). An angiogram from the Mullins sheath is performed to identify the internal iliac artery for cannulation. Using an angled catheter and a Glidewire through the Mullins sheath, the internal iliac artery is selected and angiography is performed through the angled catheter (►Fig. 1G).

Roadmap or Smart Mask technique can then be used to place an Amplatz wire (Boston Scientific, Boston, MA) in the

superior gluteal artery (►Fig. 1H). A marking catheter is then placed through the AFX sheath, and angiography at appropriate obliquities is again performed through the Mullins sheath for choosing component length (►Fig. 1I). At this point, the through-and-through wire can be removed. The internal iliac stent, a Viabahn (Gore, Flagstaff, AZ), is oversized by 10 to 15% in relation to the internal iliac artery with the length chosen to span the iliac limb of the main body and extend into the internal iliac artery. The Viabahn is delivered through the Mullins sheath (which is coaxially placed through the DrySeal Sheath; ►Fig. 1J). Through the AFX sheath, an AFX limb extension that is sized to the distal main body component is placed to line up proximally with the Viabahn stent and distally to extend to the seal zone within the external iliac artery (►Fig. 1K).

The superior end of the Viabahn stent graft is positioned so that the cranial aspect is several millimeters above the iliac limb extension. The AFX iliac extension is deployed first and molded using a semicompliant balloon (Coda balloon; Cook, Bloomington, IN) prior to Viabahn stent deployment. It is our practice to deploy the AFX limb first to allow for the graft fabric of the AFX device to fill any gutters and minimize the risk of a type III endoleak. The Viabahn stent is then deployed and dilated using an angioplasty balloon sized to the internal iliac artery (►Fig. 1K). Final angiographic runs are performed from the Mullins sheath to evaluate the snorkel patency (►Fig. 1L). If the snorkel graft is patent without flow restriction, then the internal iliac wire can be removed. If there is flow restriction, kissing balloon angioplasty is performed. Occasionally, a balloon expandable stent is used at the hypogastric artery origin to prevent type III endoleaks. The contralateral limb extension can then be deployed in standard fashion. Once the Mullins sheath is removed, a completion angiogram is performed to evaluate the entire graft (►Fig. 1M).

Postprocedure

The sheaths are removed with a wire left in place while securing the previously placed ProGlide sutures. Closure is checked to be hemostatic prior to removal of the wire. Distal pulses are evaluated and, if unchanged from preprocedure, anticoagulation is reversed using protamine. During this time, manual pressure is held on the access sites for 10 minutes following protamine administration to prevent excessive oozing of blood through the tract. The patients are then sent to the postanesthesia care unit and intensive care unit for overnight monitoring. Most patients repaired percu-

taneously are discharged 24 to 36 hours following admission. Following discharge, a contrast-enhanced CT scan is performed in 30 days to evaluate for endoleaks (►Figs. 1N–P). Outpatient follow-up is also performed to ensure there is no new-onset claudication, signs of limb thrombosis, or other symptomatology that would require immediate or long-term management.

Discussion

The sandwich endograft technique, placement of two parallel stents into two outflow arteries from a more proximal graft, can maintain blood flow to the internal iliac artery in patients with complex aortic and iliac aneurysmal disease where conventional methods would require hypogastric artery occlusion. Although not yet currently commercially available in the United States, iliac branch devices will likely supplant this technique in the near future. Up to 40% of AAAs have associated iliac artery aneurysms that can complicate landing and seal zones for endovascular aortic repair. Although coverage and/or embolization with coverage can allow for adequate distal seal, there are rare but potentially devastating complications associated with bilateral internal iliac embolization. This technique allows for iliac preservation with off-the-shelf FDA-approved devices in an off-label manner. Although long-term results are lacking, short- and midterm data suggest similar patency compared with investigational branched iliac devices. Given the lack of long-term data, risks of type III endoleak, and risks of potential limb thrombosis, we reserve this technique for preservation of a single hypogastric artery during EVAR when conventional methods would require bilateral hypogastric artery occlusion. We continue to use conventional methods of hypogastric embolization and graft extension into the external iliac artery if preservation of a single hypogastric artery is possible.

Suggested Readings

- 1 Mehta M, Veith FJ, Darling RC, et al. Effects of bilateral hypogastric artery interruption during endovascular and open aortoiliac aneurysm repair. *J Vasc Surg* 2004;40(4):698–702
- 2 Wolpert LM, Dittrich KP, Hallisey MJ, et al. Hypogastric artery embolization in endovascular abdominal aortic aneurysm repair. *J Vasc Surg* 2001;33(6):1193–1198
- 3 Ehsan O, Murray D, Farquharson F, Serracino-Inglott F. Endovascular repair of complex aortic aneurysms. *Ann Vasc Surg* 2011;25(5):716–725