Bifurcated unibody aortic endografts can overcome unfavorable aortoiliac anatomy for deployment of bilateral iliac branch endoprostheses

Arash Fereydooni, MS,[a] Christine Deyholos, MD,[b] Robert Botta, MD,[b] Nariman Nezami, MD,[c] Alan Dardik, MD, PhD,[b,d] *and* Naiem Nassiri, MD, RPVI,[b,d] *New Haven and West Haven, Conn*

ABSTRACT

In conjunction with traditional modular bifurcated aortic endografts, bilateral iliac branch endoprostheses have been safely and effectively used for treatment of bilateral iliac artery aneurysms. However, anatomic constraints, such as inadequate renal artery to iliac bifurcation lengths and unfavorable aortic anatomy, can preclude deployment in certain configurations and limit use in many patients. We present an innovative technique to overcome such anatomic constraints and to extend the reach of iliac branch endoprosthesis technology in patients with iliac artery aneurysms. (J Vasc Surg Cases and Innovative Techniques 2019;5:174-8.)

Keywords: Iliac aneurysm; Endovascular aneurysm repair; Iliac branch endoprosthesis; Aortic aneurysm

Common iliac artery (CIA) aneurysms may extend to and include the iliac bifurcation, complicating treatment of isolated CIA aneurysms with endovascular methods. Recently, iliac branch endoprostheses (IBEs) have been used to preserve internal iliac artery (IIA) patency during endovascular repair of CIA or aortoiliac aneurysms that lack an adequate CIA distal landing zone. Studies reported successful repair of CIA aneurysms initially with the Zenith IBE (Cook Medical, Bloomington, Ind)[1,2] and later with the Excluder IBE (Gore Medical, Flagstaff, Ariz).[3-5] Although only a minority of patients in these trials had bilateral CIA aneurysms, Maldonado et al[6] recently showed excellent technical success and short-term patency rates for bilateral Gore IBEs in patients with bilateral CIA aneurysms.

Whereas small case series and scant case reports have reported on the successful off-label use of isolated IBEs for treatment of isolated iliac artery aneurysms, the instructions for use (IFU) recommend the use of the Gore IBE in conjunction with the Excluder aortic endoprosthesis. This on-label combination, however, requires specific renal artery to iliac bifurcation lengths as well as aortic luminal adequacy to accommodate a modular bifurcated device and to facilitate contralateral gate opening and cannulation (Table). Concomitant aortoiliac occlusive disease, narrow distal aortic domain, and inadequate renal artery to iliac bifurcation lengths preclude application of IBE technology. Herein, we describe a novel approach with off-label use of endograft devices that overcome these specific anatomic restrictions and facilitate deployment of bilateral IBEs for repair of bilateral CIA aneurysms. This technique can also be applied to unilateral CIA aneurysms.

CASE REPORT

Presentation. An 82-year-old man with a history of hypertension, hyperlipidemia, myocardial infarction, coronary artery bypass surgery, chronic obstructive pulmonary disease requiring home oxygen, and colon cancer requiring partial colectomy was referred for evaluation and treatment of expanding bilateral CIA aneurysms measuring 3.5 to 4 cm on computed tomography angiography (CTA; Fig 1, *A*). The inferior mesenteric artery and IIA were noted to be patent. Given the history of colon resection and the inherent mesenteric flow disruption, maintaining IIA flow would preserve the superior rectal arterial collateral network. Therefore, to preserve pelvic and colon perfusion, placement of bilateral IBEs was preferred. However, CTA and centerline three-dimensional reconstruction showed a short, diseased infrarenal aorta unable to accommodate a traditional modular bifurcated device (Fig 1, *B* and *C*). In addition, there were inadequate proximal CIA IBE landing zones, precluding IBE insertion without an aortic component. To overcome these anatomic restrictions, a bifurcated unibody aortic endoprosthesis (AFX; Endologix, Irvine, Calif) was used to reconstruct the

From the Yale University School of Medicine,[a] and the Division of Vascular and Endovascular Surgery, Department of Surgery,[b] and Department of Radiology and Biomedical Imaging,[c] Yale University School of Medicine, New Haven; and the VA Connecticut Healthcare System, West Haven.[d]

Author conflict of interest: N.N.: Consultant and Speakers' Bureau, W. L. Gore, Inc.

Presented as a video presentation in the Aortic section of the Forty-seventh Annual Symposium of the Society for Clinical Vascular Surgery, Boca Raton, Fla, March 16-20, 2019.

Correspondence: Naiem Nassiri, MD, RPVI, Associate Professor of Surgery (Vascular), Yale University School of Medicine, Boardman 204, 330 Cedar St, New Haven, CT 06510 (e-mail: naiem.nassiri@yale.edu).

The editors and reviewers of this article have no relevant financial relationships to disclose per the Journal policy that requires reviewers to decline review of any manuscript for which they may have a conflict of interest.

2468-4287

https://doi.org/10.1016/j.jvscit.2019.01.004

Table. Anatomic measurements in the patient and criteria for Gore iliac branch endoprosthesis (*IBE*)

Anatomic structure	Patient's three-dimensional reconstruction measurements	Gore IBE criteria	Proposed Endologix and bilateral Gore IBE criteria
Proximal aortic neck diameter	19.5 mm	19-32 mm	Dependent on patient's measurements
Distal aortic neck diameter	21.7 mm	≥18 mm for two iliac legs and ≥23 mm for IBE and iliac leg	
Aortic diameter at bifurcation	24.8 mm		
Right CIA diameter	39 mm	<25 mm	≥20 mm
Left CIA diameter	35 mm		
Right CIA length	87.8 mm	≥55 mm	≥30 mm
Left CIA length	100 mm		
Right EIA diameter	8.2-8.7 mm	6.5-25 mm	
Left EIA diameter	8.9-10.5 mm		
Distance of lowest renal artery to iliac bifurcation	143 mm	≥165 mm for unilateral IBE	None
		≥195 mm for bilateral IBE	

CIA, Common iliac artery; *EIA*, external iliac artery.

aortic bifurcation (Fig 1, *D* and *E*) and to accommodate adequate proximal iliac landing zones for bilateral IBE placement. This technique also eliminated the short renal artery to iliac bifurcation length requirement.

Surgical technique. Percutaneous femoral access was obtained bilaterally after preclosure with suture-mediated closure devices (ProGlide; Abbot Vascular, Abbott Park, Ill). Flush abdominal aortography with iliofemoral runoff verified the previously mentioned CTA findings. An Endologix AFX aortic endoprosthesis was advanced and deployed at the aortic bifurcation per usual standard protocol (Fig 2, *A* and *B*). The aortic dimensions of the endograft were 25 mm in width by 70 mm in length; the iliac limbs were 20 mm in width by 30 mm in length. These dimensions would allow adequate overlap and width compatibility with the IBEs bilaterally. Repeated aortography showed satisfactory reconstruction of the aortic bifurcation that would accommodate bilateral IBEs with adequate seal zones as well as overlap within the limbs of the AFX device.

The right (23- × 10- × 100-mm) and then the left (23- × 12- × 100-mm) IBEs were deployed in the usual standard fashion, except for the following technical nuances. An 18F DrySeal sheath (Gore) was placed in the right common femoral artery, and a 16F DrySeal sheath was placed in the left common femoral artery. To avoid inadvertent entanglement of wire and stent graft struts, the wires used in the delivery of the AFX device were left in place, and the snare technique was performed outside and proximal to the deployed AFX device in the following fashion. An EN Snare system (Merit Medical, South Jordan, Utah) was advanced through the left side into the aorta just proximal to and outside of the AFX endograft. A Rosen wire (Cook Medical) introduced from the right side was then snared at this location and retracted up and over the bifurcation to minimize the risk of snaring the wire through the interstices of the AFX stent struts (Fig 2, *B*). This snared platform was used for the contralateral side. For both IIAs, we chose an 8- × 79-mm balloon-expandable VBX covered stent (Gore) with the L configuration, which allows postdilation and oversizing of the stent to a maximum diameter of 16 mm. Postdilation was performed with kissing balloon angioplasty of the external iliac artery component of the IBE and the IIA stent (Fig 2, *C* and *D*). Angioplasty of all remaining aortoiliac stent graft portions and overlap zones was performed with a Reliant balloon (Medtronic, Minneapolis, Minn).

Completion angiography showed a widely patent aortoiliac system and distal runoff with complete exclusion of the CIA aneurysms and no evidence of endoleak on acute- or delayed-phase angiography (Fig 2, *E*).

Postoperative course. The patient had no perioperative complications and was discharged home on postoperative day 1. Follow-up CTA at 30 days revealed a patent reconstruction with no evidence of type I, type II, or type III endoleak or stent graft incompatibility (Fig 2, *F*). On 6-month follow-up imaging, the iliac aneurysms were reduced in size to 3.1 cm bilaterally. The stents were widely patent with no evidence of endoleak or migration (Fig 2, *G*). The patient consented to publication of this report.

DISCUSSION

This is the first report to date describing the use of a bifurcated unibody aortic endograft to facilitate bilateral IBE deployment. By relining and reconstructing the aortic bifurcation, we developed new proximal CIA landing zones for the IBE main body on each side; the new proximal landing zones obviate inadequate renal artery to iliac bifurcation lengths by forgoing the need

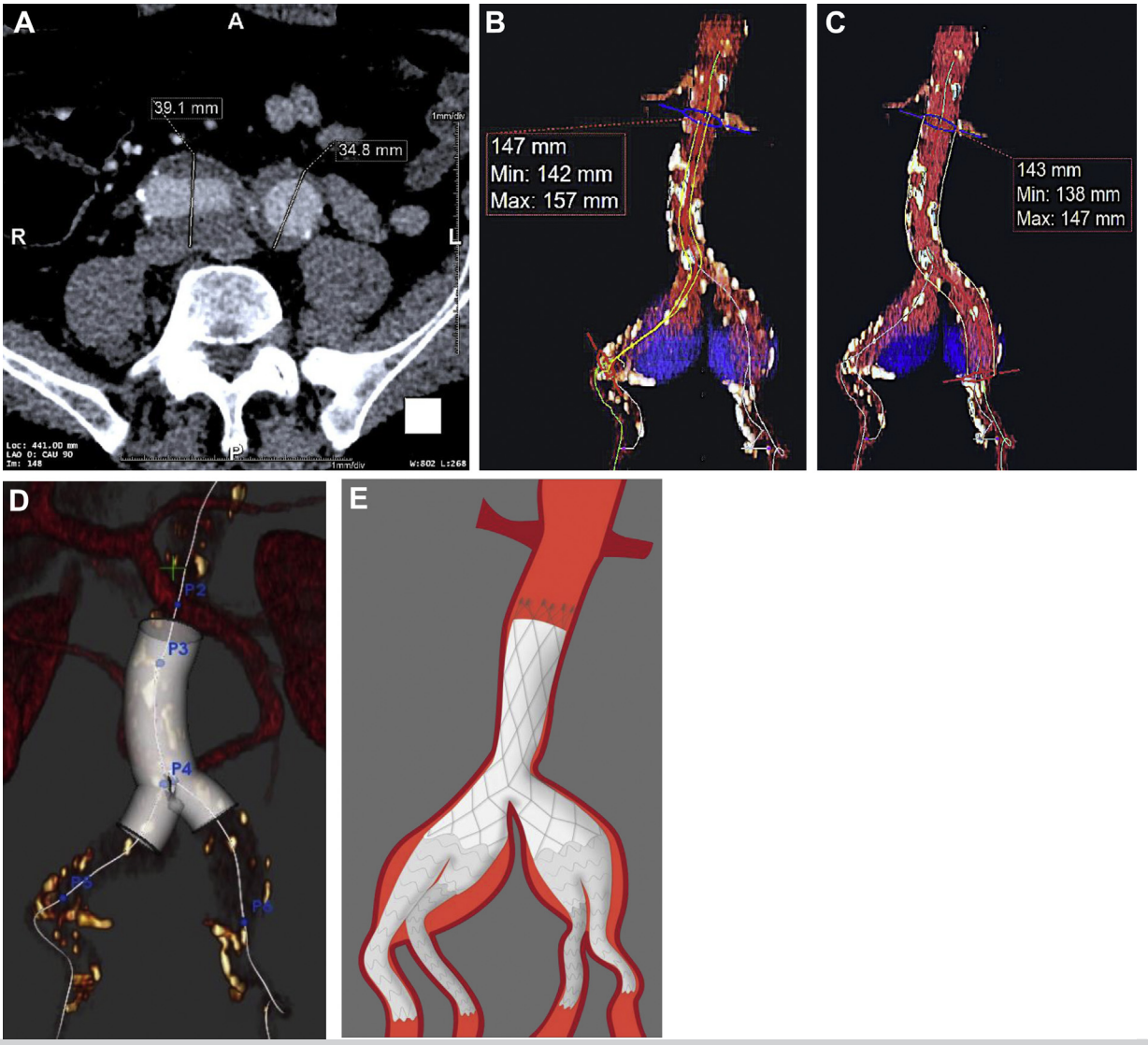

Fig 1. Preoperative imaging, measurements, and planning. **A,** Expanding bilateral common iliac artery (CIA) aneurysms measuring 35 to 40 mm on computed tomography angiography (CTA). **B** and **C,** Centerline three-dimensional reconstruction measuring the distance of the lowest renal artery to **(B)** the right internal iliac artery (IIA) as 147 mm and **(C)** the left IIA as 143 mm. **D,** The interventional roadmap for AFX endograft deployment. **E,** Preintervention planning to use a bifurcated unibody aortic endograft to reconstruct the aortic bifurcation, allowing deployment of iliac branch endoprostheses (IBEs) to repair bilateral CIA aneurysms.

for concomitant deployment of a traditional modular bifurcated aortic endograft. An additional benefit is avoiding the need to open and to cannulate a contralateral gate in a narrow, diseased infrarenal aorta. Furthermore, the possibility of iliac limb stenosis in a narrow, diseased aorta was also eliminated. Although it was not necessary in this case, more proximal placement of the AFX endograft may provide even more working length for IBE positioning and be a necessary maneuver in some patients.

Whereas most patients can tolerate unilateral IIA occlusion, the rate of pelvic ischemia secondary to unilateral IIA occlusion remains relatively high. A meta-analysis of 61 studies including 1125 patients undergoing unilateral IIA occlusion reported a 29.2% incidence of buttock claudication and 10% incidence of erectile dysfunction.[7] Given this patient's history of colon resection that likely disrupted the collateral pelvic vascular network, we preserved bilateral IIA flow at the time of aneurysm repair.

The IFU-based anatomic limitations preclude a large number of CIA aneurysms from IBE treatment. Approximately one-third of the patients in two large studies did not meet the IFU criteria for commercially available IBEs.[8,9] Pearce et al[10] reported that only 18% to 25% of screened patients were eligible for IBE purely on the basis of anatomic criteria. The most common exclusion

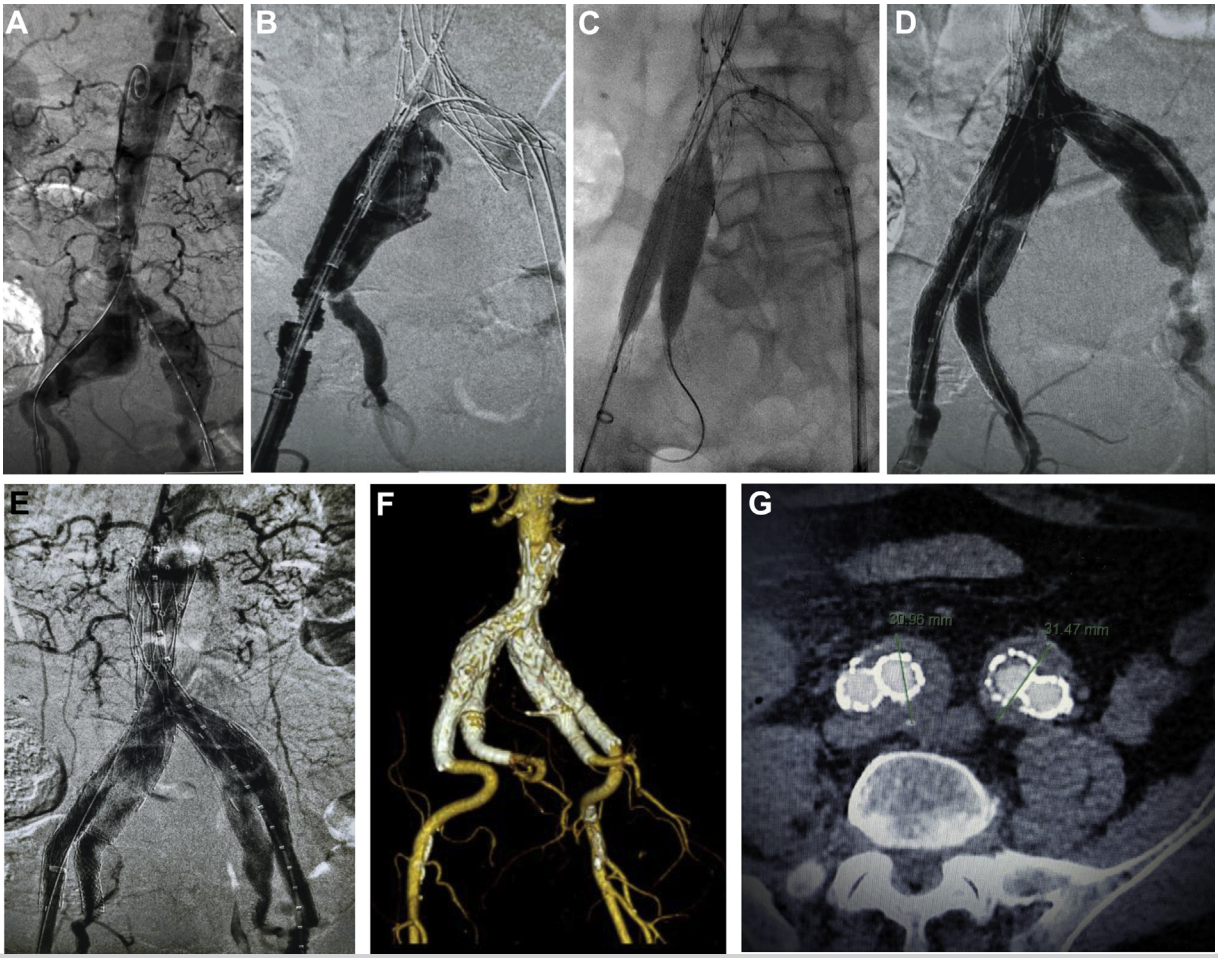

Fig 2. Intraoperative and postoperative imaging. **A,** Aortogram demonstrating a widely patent aorta and bilateral common iliac artery (CIA) aneurysms extending to the bifurcation with patent internal iliac arteries (IIAs) and external iliac artery (EIA). **B,** Snaring of the wire proximal to and outside of the AFX endograft and through the bilateral common femoral arteries to facilitate the deployment of the right iliac branch endoprosthesis (IBE). **C,** Kissing balloon angioplasty of the EIA component of the IBE and the IIA stent to seal the right CIA aneurysm. **D,** Angiogram demonstrating patency of the unibody endograft and of the right IBE and its IIA and EIA limbs, with no endoleak. **E,** Completion angiogram showing a widely patent endograft in the aorta, CIAs, EIAs, and IIAs, without endoleak or kinks. **F,** Three-dimensional reconstruction of the 30-day postoperative computed tomography angiography (CTA) image showing complete exclusion of bilateral CIA aneurysms. **G,** On 6-month follow-up imaging, the iliac aneurysms had shrunk to approximately 3.1 cm on both sides.

criterion for the Gore IBE is inadequate proximal CIA diameter to allow complete opening of the device.[10] Concomitant use of Gore Excluder further restricts eligibility for bilateral IBEs on the basis of the requirement of a renal artery to iliac bifurcation length of ≥195 mm to accommodate the Excluder iliac limb and the bilateral IBE main bodies.[6] Maldonado et al[6] highlighted this limitation as 46% of patients were ineligible for implantation of bilateral Gore IBEs.

Whereas this technique extends the reach of IBE technology, it does not address inadequate CIA diameters or IIA seal zones. It is solely recommended as an adjunctive technique to facilitate IBE in patients with inadequate proximal CIA seal zone or short aortoiliac anatomy that precludes concomitant use of a modular bifurcated aortic endograft and associated iliac limbs.

REFERENCES

1. Ferreira M, Monteiro M, Lanziotti L. Technical aspects and midterm patency of iliac branched devices. J Vasc Surg 2010;51:545-50; discussion: 550.
2. Bisdas T, Weiss K, Donas KP, Schwindt A, Torsello G, Austermann M. Use of iliac branch devices for endovascular repair of aneurysmal distal seal zones after EVAR. J Endovasc Ther 2014;21:579-86.
3. Schneider DB, Matsumura JS, Lee JT, Peterson BG, Chaer RA, Oderich GS. Prospective, multicenter study of endovascular

repair of aortoiliac and iliac aneurysms using the Gore Iliac Branch Endoprosthesis. J Vasc Surg 2017;66:775-85.
4. van Sterkenburg SM, Heyligers JM, van Bladel M, Verhagen HJ, Eefting D, van Sambeek MR, et al. Experience with the GORE EXCLUDER iliac branch endoprosthesis for common iliac artery aneurysms. J Vasc Surg 2016;63:1451-7.
5. Millon A, Della Schiava N, Arsicot M, De Lambert A, Feugier P, Magne JL, et al. Preliminary experience with the GORE EXCLUDER iliac branch endoprosthesis for common iliac aneurysm endovascular treatment. Ann Vasc Surg 2016;33:11-7.
6. Maldonado TS, Mosquera NJ, Lin P, Bellosta R, Barfield M, Moussa A, et al. Gore Iliac Branch Endoprosthesis for treatment of bilateral common iliac artery aneurysms. J Vasc Surg 2018;68:100-8.e3.
7. Bosanquet DC, Wilcox C, Whitehurst L, Cox A, Williams IM, Twine CP. Systematic review and meta-analysis of the effect of internal iliac artery exclusion for patients undergoing EVAR. Eur J Vasc Endovasc Surg 2017;53:534-48.
8. Gray D, Shahverdyan R, Jakobs C, Brunkwall J, Gawenda M. Endovascular aneurysm repair of aortoiliac aneurysms with an iliac side-branched stent graft: studying the morphological applicability of the Cook device. Eur J Vasc Endovasc Surg 2015;49:283-8.
9. Karthikesalingam A, Hinchliffe RJ, Malkawi AH, Holt PJ, Loftus IM, Thompson MM. Morphological suitability of patients with aortoiliac aneurysms for endovascular preservation of the internal iliac artery using commercially available iliac branch graft devices. J Endovasc Ther 2010;17:163-71.
10. Pearce BJ, Varu VN, Glocker R, Novak Z, Jordan WD, Lee JT. Anatomic suitability of aortoiliac aneurysms for next generation branched systems. Ann Vasc Surg 2015;29:69-75.

Submitted Oct 21, 2018; accepted Jan 27, 2019.