Using a Surgeon-modified Iliac Branch Device to Preserve the Internal Iliac Artery during Endovascular Aneurysm Repair: Single-center Experiences and Early Results

Wei-Wei Wu1,2, Chen Lin1, Bao Liu2, Chang-Wei Liu2

1Department of Vascular Surgery, Beijing Tsinghua Changgung Hospital, Medical Center, Tsinghua University, Beijing 102218, China
2Department of Vascular Surgery, Peking Union Medical College Hospital, Chinese Academy of Medical Science, Beijing 100730, China

Abstract

Background: To evaluate the feasibility of a new surgeon-modified iliac branch device (IBD) technique to maintain pelvic perfusion in the management of common iliac artery (CIA) aneurysm during endovascular aneurysm repair (EVAR).

Methods: From January 2011 to December 2013, a new surgeon-modified IBD technique was performed in department of vascular surgery of Peking Union Medical College Hospital in five patients treated for CIA aneurysm with or without abdominal aortic aneurysm. A stent-graft limb was initially deployed in vitro, anastomosed with vascular graft, creating a modified IBD reloaded into a larger sheath, with or without a guidewire preloaded into the side branch. The reloaded IBD was then placed in the iliac artery, with a covered stent bridging internal iliac artery and the branch. Finally, a bifurcated stent-graft was deployed, and a limb device was used to connect the main body and IBD.

Results: Technical successes were obtained in all patients. The mean follow-up length was 24 months (range: 6–38 months). All grafts remained patent without any sign of endoleaks. There were no aneurysm ruptures, deaths, or other complications related to pelvic flow.

Conclusions: Using the surgeon-modified IBD to preserve pelvic flow is a feasible endovascular technique and an appealing solution for personalized treatment of CIA aneurysm during EVAR.

Key words: Abdominal Aortic Aneurysm; Common Iliac Artery Aneurysm; Endovascular Repair; Internal Iliac Artery; Modified Iliac Branch Device

Introduction

Endovascular aneurysm repair (EVAR), emerging as a minimally invasive technique, has become increasingly applied in addition to conventional open repair in patients with abdominal aortic aneurysm (AAA). Up to 54% of AAAs involves with common iliac artery (CIA) aneurysms, and <2% of all intra-abdominal aneurysms are isolated iliac aneurysms. In these patients, however, the presence of iliac branches disorders disturb landing and limit the popularization of EVAR. Thus, intentional blocking of one or both internal iliac arteries (IIAs) is often necessary after the extension of the endograft across the orifice of the IIA to secure distal fixation into the external iliac artery (EIA). It has been well-recognized that patients with deliberate interruption of the pelvic perfusion may experience buttock claudication, erectile dysfunction, and even severe ischemic complications.

Measures should be taken to preserve pelvic flow whenever possible for potential benefits of those patients who are at high risk of ischemic complications, as yet this subgroup remaining unidentified. In addition to open and hybrid procedures, less invasive means have been explored, including iliac branched stent-grafts, commercial or surgeon-made. The commercial devices demonstrated a favorable intraoperative performance and long-term outcomes. Because the commercial devices are limited by certain hostile anatomical features and are not State Food and Drug Administration (SFDA)-approved in China, we hereby report a successful endovascular alternative, describe the initial results, and discuss some technical aspects of a new surgeon-modified iliac branch device (IBD) in aortoiliac aneurysms or isolated iliac aneurysms exclusion.

Methods

Ethics statement

The involved patients had been explained with the details of the modified device and how the treatment would be...
processed. An informed, written consent had been obtained before each procedure. The treatment was approved by the ethical committee of our institute.

**Subjects and Methods**

From January 2011 to December 2013, a new surgeon-modified IBD technique was performed in department of vascular surgery of Peking Union Medical College Hospital in five patients (all males, 70.2 ± 4.3 years old) treated for AAA and bilateral CIA aneurysms (n = 2), or bilateral CIA aneurysms (n = 2), or AAA and unilateral CIA aneurysm with contralateral IIA occlusion (n = 1). The maximum diameter of CIA was 52.4 ± 5.6 mm. Inclusion criteria were the presence of CIA aneurysm extending to iliac bifurcation, the diameter of the distal end of the CIA was larger than 22 mm, and the target IIA to be reconstructed must be patent and <12 mm in its maximum diameter. The patient whose contralateral IIA existed and can be preserved by routine endovascular technique, or who did not agree the inform consent, would be excluded.

The technique was illustrated in a 69-year-old man with asymptomatic aneurysms involving bilateral CIs and left IIA. The plan was to insert a modified IBD into the right iliac artery with its branch toward the right patent IIA, deploy a covered stent to bridge the right IIA and side branch to keep pelvic flow, then embolize left IIA, place a bifurcated stent-graft on the bifurcation, and place an extension to connect main body and IBD [Figure 1].

The procedure was performed under general anesthesia beginning with administration of unfractionated heparin (80–100 U/kg). Prophylactic antibiotics were given 30 min before the procedure. An on-table IBD modification was prepared. A 16 mm³ × 12 mm³ × 120 mm² MicroPort iliac stent-graft limb (MicroPort, Shanghai, China) was selected based on the landing zone diameter of right EIA. The whole limb was deployed in vitro [Figure 2a]. An elliptical graftotomy 45° oblique to the long axis was performed to the third stent at about 30 mm to its proximal end for a secure overlap of the limb extender, using vascular scissors [Figure 2b]. Then, a 7 mm expanded polytetrafluoroethylene (PTFE) vascular graft (Gore, Flagstaff, AZ, USA) was anastomosed end-to-side to the modified limb with its beveled cut end [Figure 2c]. The strut of the arm graft was secured helically to the iliac limb with several sutures [Figure 2d]. The side arm was tailored to 30 mm long, and two metal markers were sewed at both ends of the arm graft for orientation [Figure 2e]. Lastly, this modified device [Figure 2f] was reloaded into a 22-F sheath (MicroPort, Shanghai, China) with no guidewire preloaded [Figure 2g].

After the initial angiography [Figure 3a], the IBD was advanced into the right CIA just inferior to the aortic bifurcation and extended into the EIA. The distal end of the arm graft was positioned 10 mm proximal direct to the patent IIA orifice. After the IBD was deployed, through a cross-over approach via the contralateral femoral artery, and through the IBD and its side branch, the distal right IIA was selectively catheterized, and a stiffer 0.035-inch Supra Core wire (Abbott, Santa Clara, CA, USA) was then exchanged. A 10-F artery sheath (SearCare, Shenzhen, China) was introduced into the IIA via the guiding of a half-inflated 5 mm-diameter balloon catheter (Cordis, Oostende, LJ Roden, The Netherlands). Then, a self-expandable Fluency covered stent (Bard, Wachhaustrasse, Karlsruhe, Germany) measuring 8 mm × 80 mm was delivered through the sheath and deployed to span the distance from the proximal end of the side branch into the right IIA.

After the successful preservation of the right IIA, the left IIA was embolized with coils (Cook, Bloomington, IN, USA) into its proximal end via ipsilateral common femoral artery (CFA). Then, a standard EVAR was performed by delivering a bifurcated stent-graft main body device measuring 24 mm³ × 12 mm³ × 170 mm³ (MicroPort, Shanghai, China) through a left CFA approach over 0.035-inch Lunderquist extra stiff wire (Cook, Bjaeverskov, Denmark), with the proximal end just below the renal arteries and the distal left end beyond the orifice of the embolized IIA into the EIA. At last, a 16 mm³ × 16 mm³ × 80 mm³ limb device (Medtronic, Galway, Ireland) was placed into the right CIA to bridge the
main body and IBD using a right CFA access. Appropriate balloon dilation was performed at the proximal and distal attachment sites and in the overlapping zones. Repeated angiography demonstrated complete exclusion of unilateral IIA aneurysm in addition to bilateral CIA aneurysms with no sign of endoleak, and patent renal arteries and preserved IIA with its branches.

The technique was performed in five patients with excellent results and was modified when reloading the modified IBD in the recent four patients. Before reloading into the sheath, modified IBD was preloaded with a guidewire into its side branch through the proximal end of the branch graft. The soft tip of the guidewire ran out parallel with the tip of the reloading sheath. Thereby, the following way was used to capture the end of the guidewire. First, a catheter was delivered out of the ipsilateral CFA from the contralateral CFA to create a through-and-through passage. After the body of the preloaded guidewire was inserted into the catheter, it was captured from the contralateral side. The IBD was delivered into the ipsilateral iliac artery simultaneously with the retraction of the catheter till the aortic bifurcation. The IBD was partially released, and the side branch was open direct to the IIA orifice. The soft tip of the guidewire was positioned into the IIA under the help of the catheter. Then a cross-over long artery sheath was put into the IIA via the guidewire, through which a covered stent was delivered. Finally, the distal part of the IBD was full-released.

Moreover, the recent three patients were treated with balloon-expandable Jostent stent-grafts (Abbott, Rangendingen, Germany) to bridge the arm graft and large IIA, with the stent in arm graft dilated into 7–8 mm, and 10–12 mm in the IIA portion, making it look like an “up-side-down taper”.

Results
Technical successes were obtained in all of the five patients with aneurysms repaired, and target IIAs reconstructed. Completing angiography showed a mild Type II endoleak in one patient, which disappeared 3 months later. The mean follow-up length was 24 months (range: 6–38 months). All grafts remained patent without any sign of migration, fracture or endoleaks, and IIA flow was preserved. There were no aneurysm ruptures, deaths, or other complications related to pelvic flow. Aneurysm shrinkage of >5 mm was seen in all patients in computed tomography (CT) scan. No aneurysm enlargement was observed in any patient.

Discussion
Many studies have thoroughly discussed the complications of IIA embolization. Buttock claudication and erectile dysfunction are most frequent complications. Bilateral occlusion of the
IIA flow may increase the risk of severe ischemic symptoms, developing bowel or bladder ischemia, buttock necrosis, spinal cord injury, and acute limb ischemia. Most authors agree on maintaining the flow of at least one IIA while excluding aortoiliac or solitary iliac aneurysm whenever possible.[1,2,11]

Various techniques for preservation of the IIA flow include open, hybrid,[4,5,10,11] and endovascular procedures.[6-9] It has been widely accepted that the conventional invasive open surgery is not the first choice for AAA exclusion. At the time of EVAR for the exclusion of aortoiliac aneurysms and isolated iliac aneurysms, CIA is the most common distal attachment site. For patients with smaller CIA aneurysms <22 mm in diameter, flared iliac limbs, with long-term safety results of a recent large prospective study,[12] or “bell-bottom” cuffs[8] may be the choice to achieve a distal seal.

Patients with large CIA aneurysms ≥22 mm often require extension of the endograft into the EIA, which may inevitably result in IIA covering. Some groups developed hybrid procedure to preserve pelvic flow, via IIA transposition or bypass combined with endovascular repair.[5,10] The hybrid technique was safe and effective according to the literature and our experiences; however, it still requires flank retroperitoneal incision and adds some additional invasions to the endovascular techniques. Bergamini et al. introduced four cases with Grade IIC AAA using a technique of an aortouniliac graft with external-to-internal iliac stent-grafts in addition to femoro-femoral bypass.[13] We have completed five cases till now by this method as well, despite the anatomic limitations with respect to the CIA neck, the EIA to IIA angle, and proximal and distal iliac landing zones, which may increase risk of technique failure, graft occlusion and separation, and severe Type I endoleak.[11]

Delle et al. described a procedure of bifurcated stent-grafts with one limb extended into an IIA followed by a surgical ligation of EIA and a femoro-femoral cross-over to preserve the pelvic circulation.[14] However, the aforementioned two hybrid alternatives still required a surgical bypass with various underlying complications.

Iliac branched graft concurrent with bifurcated graft has been initially described by Iwase et al. in 1999. Abraham et al. reported the attempt of modular stent-graft,[15] which demonstrated the early prototype of Zenith bifurcated iliac side device with a straight and short side branch, one of the two commercially available IBDs outside China. The other device, helical branch endograft, was designed by Greenberg et al. with a tubular side branch in a helical fashion. Karthikesalingam et al. reviewed all the seven unique case series of 196 patients applying IBDs from 1996 to 2009.[17] Technical success was 85–100%, and a low rate of endoleak developed, one Type I and two Type III
endoleaks. In recent studies, Verzini et al. group and others reported similar technical success rates of 94–97% and primary patency rates of 89–93% from a follow-up of 12–22 months. Since the commercial device cannot meet all the anatomical demands, some novel technique of modified iliac branched device has been described. Casey group removed the upper two Z-stent rings of a bifurcated cook Zenith stent-graft to achieve the aortoiliac aneurysm exclusion with good short-term results. This endovascular repair can be advocated especially in the area without FDA-approved IBDs. Oderich and Ricotta modified a commercially approved iliac stent-graft with a pre-sewn polyester side graft, nearly identical to the newer-generation of Zenith IBD. This procedure was technically successful with no complications. And of all three cases, none proved graft endoleakage during 9-month follow-up.

Since the aforementioned two commercial IBDs have not been SFDA-approved in China yet, hereby, we present the modified flexible use of a new surgeon-modified commercial IBD since January 2011, which has yet not been reported in China. Elderly, higher risk patients and iliac aneurysms with wide and long CIAs were preferred to this approach. Precise preoperative design via computed tomographic angiography (CTA) is of predominant importance. The distal end of the side branch should have a minimal redundancy of 1 cm for guidewire to enter the IIA. The decision of preserved side of IIA equally depends on CTA. If the IIA trunk was tortuous, short <2 cm, or aneurysmal dilated >13 mm, it should not prefer reconstruction.

Polyester or PTFE vascular graft of 7–8 mm is the choice for an arm graft. It can be attached to the iliac limb in a style of helix or dissociation depending on the diameter and length of the CIA aneurysm. If the CIA neck is short, the helix style is preferred because it extends the landing zone. Not like the IBD designed by Oderich and Ricotta, an elliptical graftotomy 45° oblique to the long axis of the limb extender was made and the side branch was sutured obliquely like the helix style in our IBD. The branch structure can be strengthened by several sutures to the nearby metal skeletons of the graft, with metal markers resewed on both ends of the side branch for location.

Creating access into the side branch, and IIA is most challenging. Preloaded guidewire can be adopted for easier selection of the side branch as we described in the latter four cases. A catheter-delivered out of the ipsilateral CFA from the contralateral creating a through-and-through passage is needed to capture the preloaded guidewire. If it is difficult for hard sheath to cross-over the bifurcation, choose an even stiffer guidewire or block an aortic balloon above the bifurcation by Coda (Cook, Bloomington, IN, USA) or Reliant (Medtronic, Galway, Ireland) balloon for example, to facilitate and reflex the sheath into the extending limb and arm. Besides, a half-inflated companion balloon can be chosen to guide and support artery sheath to process into the IIA.

Finally, the type of stent-graft used to span the distance from the arm graft into the IIA, self-expandable or balloon-expandable, depends on tortuosity and diameter of the IIA. In the recent three cases, we used Jostent stent-grafts (Abbott, Rangendingen, Germany), with a maximum diameter of 12 mm, to connect the branch and the IIA. To our experience, for large IIA of 9–12 mm in diameter with a straight main trunk, a balloon-expandable covered stent is preferred. For the proximal and distal part of the stent can be expanded to different diameters and cover the diameter discrepancy between the IIA and side branch in an “up-side-down taper” manner, as described previously. If a large-diameter self-expandable stent is used here, the proximal part of the stent will be twinkled in the side branch and may cause future stenosis or occlusion. For tortuous IIA like a helix, self-expandable would be the first choice based on better flexibility.

In conclusion, using the surgeon-modified IBD to preserve IIA flow is a feasible endovascular technique in complex aortoiliac aneurysms or solitary iliac aneurysms exclusion with encouraging technical success rate and satisfying early results. It can be considered as one of the appealing solutions for minimal invasive and personalized treatment, and may be more cost-effectiveness among all the endovascular options. However, long-term follow-up and larger sample size, as well as standardized criteria to identify patients who will benefit most from this new modified IBD is required to determine the benefits of this approach.

References

1. Hobo R, Sybrandy JE, Harris PL, Buth J, EUROSTAR Collaborators. Endovascular repair of abdominal aortic aneurysms with concomitant common iliac artery aneurysm: Outcome analysis of the EUROSTAR Experience. J Endovasc Ther 2008;15:12-22.
2. Karthikesalingam A, Hinchliffe RJ, Holi PJ, Boyle JR, Loftus IM, Thompson MM. Endovascular aneurysm repair with preservation of the internal iliac artery using the iliac branch graft device. Eur J Vasc Endovasc Surg 2010;39:285-94.
3. Rayt HS, Bown MJ, Lambert KV, Fishwick NG, McCarthy MJ, London NJ, et al. Buttock claudication and erectile dysfunction after internal iliac artery embolization in patients prior to endovascular aortic aneurysm repair. Cardiovasc Intervent Radiol 2008;31:728-34.
4. Hinchliffe RJ, Hopkinson BR. A hybrid endovascular procedure to preserve internal iliac artery patency during endovascular repair of aortoiliac aneurysms. J Endovasc Ther 2002;9:488-92.
5. Arko FR, Lee WA, Hall BB, Fogarty TJ, Zarins CK. Hypogastric artery bypass to preserve pelvic circulation: Improved outcome after endovascular abdominal aortic aneurysm repair. J Vasc Surg 2004;39:404-8.
6. Verzini F, Pariani G, Romano L, De Rango P, Panuccio G, Cao P. Endovascular treatment of iliac aneurysm: Concurrent comparison of side branch endograft versus hypogastric exclusion. J Vasc Surg 2009;49:1154-61.
7. Ferreira M, Monteiro M, Lanzionti L. Technical aspects and midterm patency of iliac branch devices. J Vasc Surg 2010;51:545-50.
8. Casey K, Al-Khatib WK, Zhou W. Hypogastric artery preservation during aortoiliac aneurysm repair. Ann Vasc Surg 2011;25:133.e1-8.
9. Oderich GS, Ricotta JJ 2nd. Novel surgeon-modified hypogastric branch stent graft to preserve pelvic perfusion. Ann Vasc Surg 2010;24:278-86.
10. Lee WA, Nelson PR, Berceli SA, Seeger JM, Huber TS. Outcome after hypogastric artery bypass and embolization during endovascular
aneurysm repair. J Vasc Surg 2006;44:1162-8.

11. Wu WW, Jiang XY, Liu B, Chen Y, Liu CW. Endovascular repair of aortoiliac aneurysm with a hybrid technique to preserve pelvic perfusion. Chin Med J (Engl) 2011;124:4105-8.

12. Kirkwood ML, Saunders A, Jackson BM, Wang GJ, Fairman RM, Woo EY. Aneurysmal iliac arteries do not portend future iliac aneurysmal enlargement after endovascular aneurysm repair for abdominal aortic aneurysm. J Vasc Surg 2011;53:269-73.

13. Bergamini TM, Rachel ES, Kinney EV, Jung MT, Kaebnick HW, Mitchell RA. External iliac artery-to-internal iliac artery endograft: A novel approach to preserve pelvic inflow in aortoiliac stent grafting. J Vasc Surg 2002;35:120-4.

14. Delle M, Lönn L, Wingren U, Karlström L, Klingensmitha H, Risberg B, et al. Preserved pelvic circulation after stent-graft treatment of complex aortoiliac artery aneurysms: A new approach. J Endovasc Ther 2005;12:189-95.

15. Abraham CZ, Reilly LM, Schneider DB, Dwyer S, Sawhney R, Messina LM, et al. A modular multi-branched system for endovascular repair of bilateral common iliac artery aneurysms. J Endovasc Ther 2003;10:203-7.

Received: 31-07-2014 Edited by: Jian Gao

How to cite this article: Wu WW, Lin C, Liu B, Liu CW. Using a Surgeon-modified Iliac Branch Device to Preserve the Internal Iliac Artery during Endovascular Aneurysm Repair: Single-center Experiences and Early Results. Chin Med J 2015;128:674-9.

Source of Support: Nil. Conflict of Interest: None declared.