Stent-Graft Repair of Isolated Iliac Aneurysms with Wide or Ectatic Necks with Use of Inverted Zenith Device Legs

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Although there is considerable experience in the management of iliac artery aneurysms (IAAs) accompanying abdominal aortic aneurysms, less is known about endovascular management of isolated IAAs. The distal landing zone can be secured if necessary by extending the graft to the external iliac artery, but the proximal landing zone remains a challenging issue, on which technical success is dependent. The present report describes a novel technique for endovascular management of isolated IAAs with wide proximal necks for which no commercially available grafts with fitting sizes exist: inversion of the iliac leg of a Zenith device.

Abbreviations: IAA = iliac artery aneurysm, IIA = internal iliac artery

Isolated iliac aneurysms are rare, accounting for 0.03% of all patients (1). For many years, surgical repair has been the gold standard, but since the revolutionary introduction of endovascular technology in aortic aneurysm repair, its applications have rapidly expanded to include iliac artery aneurysm (IAA) repair. Although there is considerable experience in the management of iliac artery aneurysms (IAAs) accompanying abdominal aortic aneurysms with use of bifurcated grafts (2–5), less is known concerning the endovascular management of isolated IAAs (6,7).

Although the distal landing zone can easily be secured if necessary by extending the graft to the external iliac artery (3), an efficient and safe proximal landing zone remains a challenging issue, on which technical success is dependent. Currently, commercially available covered stents and stent-graft components of devices used for endovascular abdominal aortic aneurysm repair (eg, iliac legs or extensions) guarantee successful IAA repair in most, but not all, patients. However, IAAs with short necks (<10 mm) are excluded as a result of proximal fixation limitations, and IAAs with wide or ectatic necks (>14 mm) are excluded because of the lack of stent-grafts with large proximal diameters.

The Zenith device (William Cook Europe, Roden, The Netherlands) is currently available with legs with a standard proximal iliac diameter of 12 mm, distal iliac diameters ranging between 8 and 24 mm, and lengths of 59 to 161 mm. The Zenith device has a unique feature in that the stent can be deployed before device placement and can then be loaded again in an inverted position. Herein we report a novel technique for endovascular management of isolated IAAs with wide or ectatic proximal necks for which there are no currently commercially available grafts with fitting sizes; the technique involves the inversion of an iliac leg of a Zenith stent-graft.

CASE REPORTS

Our institution does not require approval for retrospective reporting of cases such as the present report.

Case 1

A 60-year-old man presented with left lower-quadrant abdominal pain radiating to the back. Physical examination revealed a pulsatile mass in the left iliac fossa. Computed tomography (CT) and digital subtraction angiography demonstrated an intact 11-cm × 7.5-cm isolated left common iliac aneurysm 105 mm long with an angulated, proximal neck 15 mm in length and 18 mm in diameter. A patent internal iliac artery (IIA) arose from the aneurysm (Fig 1a). The patient was assessed as American Society of Anesthesiologists grade IV. To handle the wide proximal neck while avoiding the unnecessary implantation of a bifurcated graft, we prepared a custom-made device.

Before initiating the procedure, we planned to accommodate a graft with...
a large proximal diameter by deploy-
ing the appropriate Zenith iliac leg
t graft on the back table. Inverting the
graft and reloading it into its sheath
(H&L-B One-Shot Introduction Sys-
tem; William Cook Europe) resulted in
a stent-graft with a wide proximal di-
ameter (as large as 24 mm) that could
be accommodated in a wide proximal
neck and a narrow distal diameter (12
mm) that fitted within the usual size of
the external iliac artery. Caution and
meticulous handling is needed during
loading, which should be done with
the support of a ligature that helps to
constrain the stents by circling them in
a helical manner. Stents are con-
strained and gently pushed into the
sheath while the ligature is gradually
loosened to the end of all stents while the first “twice-circled knot” is kept tight and stent-graft
is kept constricted. (e,f) The fully constrained stent-graft is pushed into the sheath and the ligature is gradually loosened by helical
circling in the opposite direction. When the graft has been fully loaded, the sheath and dilator tip (f) are approximated and the stent-graft is ready for use (g). Note the slight crimping of the sheath. (Available in color online at www.jvir.org.)

Figure 1. (a) Preoperative digital subtraction angiogram in anteroposterior view indicates the left IAA (arrow). (b) On final angiogram,
arow indicates the proximal cuff partly entering into the aortic lumen. (c) CT angiographic image at 6 months demonstrates IAA
exclusion and an intact device with no signs of migration. Note that the protrusion of the proximal cuff into the aorta (arrow) does not
alter perfusion of the right iliofemoral axis. (Available in color online at www.jvir.org.)

Figure 2. Zenith leg inversion technique. (a) Commercially available stent-graft is deployed by pulling back the sheath (b). (c,d) After
stent-graft inversion, it is reloaded into its sheath. A ligature is circled twice around the edge of the graft—but not tied—to constrain
the first stent, and then helical circling is continued to the end of all stents while the first “twice-circled knot” is kept tight and stent-graft
is kept constricted. (e,f) The fully constrained stent-graft is pushed into the sheath and the ligature is gradually loosened by helical
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is ready for use (g). Note the slight crimping of the sheath. (Available in color online at www.jvir.org.)

The endovascular procedure was
carried out via femoral cutdown, fol-
lowed by coil embolization of the
main trunk of the IIA. A double stent
procedure was planned: the distal
stent—a Zenith leg with a 12-mm dis-
tal and proximal diameter (TFLE 12-
71; William Cook Europe), landing on
the 10-mm external iliac artery—was
deployed first, followed by our cus-
tom-made device (inverted TFLE 20-
71; William Cook External, 12-mm
proximal diameter, William Cook Europe). Balloon dilation was performed at the
proximal and distal attachment sites

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and in the overlapping zones. Angiography revealed a type IA endoleak. A 22-mm Zenith aortic cuff was deployed proximally to seal the leak. Final angiography showed aneurysm exclusion with no signs of endoleak (Fig 1b). A slight—though necessary—protrusion of the aortic cuff into the aortic lumen did not compromise the right axis circulation. The 6-month CT angiography follow-up was unremarkable (Fig 1c) and 9-month clinical examination revealed no pulsatile mass and no signs of graft occlusion.

**Case 2**

A 56-year-old man was referred by his general practitioner because of an incidental diagnosis of a left common iliac aneurysm. CT angiography demonstrated a 30-mm isolated IAA that was 80 mm long with a proximal neck 25 mm in length and 16 mm in diameter (Fig 3a,b). The hypogastric artery arose within the aneurysm and the external iliac artery had a 9-mm diameter. The patient was assessed as American Society of Anesthesiologists grade III.

Following the same procedure detailed in case 1, the main trunk of the IIA was embolized. A double stent procedure was carried out, and final angiography showed aneurysm exclusion with no signs of endoleak (Fig 3c). The 3-month clinical follow-up was unremarkable.

**DISCUSSION**

The favorable early outcomes of endovascular abdominal aortic aneurysm repair in properly selected patients (8) encouraged a similar approach to IAAAs, which showed promising results in recent publications (6,7) that proved the feasibility and efficacy of the method. Iliac anatomy is variable and usually complex (eg, kinking, stenosis, calcification), requiring several adjunctive technical strategies to achieve adequate iliac aneurysm exclusion. Proximal IAA neck diameter and length, in addition to the IAA’s relation to the hypogastric artery, guide decision-making on the optimal management modality. Experience has accumulated in the management of combined abdominal and common iliac artery aneurysms by the use of bifurcated grafts (2–5), but less is known about the application of endografts in cases of a solitary IAA.

A bifurcated graft would be not only unnecessary for a healthy aortic vessel, but could even be harmful for lumbar or inferior mesenteric–IIA collateral circulation, especially in cases in which IIA embolization is considered (eg, case 2 in the present report; Fig 3c). Although rich collaterals exist in the pelvic circulation, interruption of the IIA along with the inferior mesenteric or lumbar artery may lead to pelvic arterial insufficiency, even in the presence of a patent contralateral IIA (9). A bifurcated graft could be considered for patients with diffuse atherothrombosis of the infrarenal aortic segment to cover the entire diseased segment. Bifurcated stent-grafts could also be advantageous for isolated IAAs in the absence of an adequate proximal neck (ie, >1.5 mm in length and <14 mm in diameter), but even in these cases, care is needed to avoid significant crowding of the two limbs in a small, undilated aorta.

An alternative technique for short proximal necks that spares the need for a bifurcated graft has been described recently (9). It involves proximal sealing enhancement by the use of a tube stent-graft with a proximal bare stent protruding into the aortic lumen. For wide proximal necks (>14 mm), which are currently managed with bifurcated grafts, our proposed technique is an also advantageous alternative.

Wide necks have not yet been included in available stent-grafts. The commercially available proximal diameters of iliac legs are approximately 12–16 mm and the diameters of iliac extensions are 8–22 mm, respectively. However, iliac extensions with proximal diameters greater than 16 mm have the disadvantage of a proximal open web configuration or an equally large distal diameter that does not fit into the narrower external iliac landing zone. Our proposed technique of Zenith leg stent-graft inversion is the only technical alternative of which we are aware that spares the need for a bifurcated graft and allows proximal sealing of necks as large as 22 mm in diameter. In these cases, the shortest possible length of the neck should follow the current indications, namely a 1.5-cm-long nonaneurysmal, thrombus-free artery (6).

Alternative novel techniques for IAA management emerge based on the need to maintain the IIA. New-generation iliac bifurcated devices show a favorable intraoperative performance and good long-term outcomes. However, the demanding implantation technique and higher costs associated with these devices limit their widespread use (2).

From a technical point of view, if double stent implantation is necessary to cover a long IAA, irrespective of technique used, deployment of the distal component first, followed by the proximal stent-graft, is recommended for safer anchoring of the system. Deploying the proximal component first carries the risk of distal graft migration as a result of blood pulsatile forces.

In conclusion, open IAA repair may still remain a standard therapy. However, for those patients at high risk who are considered suitable for endo-
vascular repair, several techniques are currently available to accommodate all anatomies. A wide proximal neck can be safely managed with the use of a tube graft, sparing the need for an unnecessary or unfit bifurcated graft. Until manufacturers develop modern “all-size” devices, the use of an inverted Zenith iliac leg can be an effective technique.

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References