Diagn Interv Radiol 2015; 21: 334–337

INTERVENTIONAL RADIOLOGY
TECHNICAL NOTE

Iliorenal periscope graft to maintain blood flow to accessory renal artery

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ABSTRACT
Parallel endografts such as “chimney” and “periscope” are being increasingly used to maintain blood flow to visceral and supra-aortic branches in patients with different aortic disorders. We present a new technique, “iliorenal periscope graft”, in a patient with abdominal aortic aneurysm undergoing endovascular aortic repair. In this case, left accessory renal artery flows were provided by an iliorenal periscope graft that extends from the left accessory renal artery to the right common iliac artery in a retrograde fashion.

Fenestrated and branched endografts have been developed to extend proximal and/or distal landing zone in aortic diseases with short proximal and/or distal necks; however, the applicability of these devices are currently very limited (1, 2). Parallel endografts have been recently used for the same purpose (3). These grafts can also be used to maintain flow to the accessory renal arteries. We have successfully applied a new technique similar to periscope graft (PG), in which the PG is extended from the accessory renal artery (ARA) to the common iliac artery (CIA) and blood flow of the ARA is maintained by the iliorenal periscope graft (IRPG) in a retrograde fashion.

Technique

Case description

A 73-year-old male was admitted to our hospital with abdominal pain. His past medical history was significant for coronary artery disease and chronic obstructive pulmonary disease. Computed tomography (CT) angiography revealed a 45 mm abdominal aortic aneurysm (AAA) and two pseudoaneurysmatic sacs localized at the level of the 3rd and 4th lumbar vertebrae originating from the AAA measuring 16 mm and 14 mm, respectively. Infrarenal aortic neck was 24 mm, neck angle was 10 degrees, and both iliac arteries were 14 mm. Endovascular aortic repair was planned.

CT angiography showed a left ARA with a diameter of 5 mm, originating 18 mm below the left main renal artery. Mild stenoses were also noted in the proximal left ARA and the right renal artery (Fig. 1). Left ARA was supplying perfusion to approximately half of the renal parenchyma. Since the distance between ARA to iliac bifurcation was 80 mm, it was not safe enough to deploy contralateral limb of the stent-graft (Zenith Flex, Cook Inc.), so we planned to maintain blood flow to ARA with a chimney graft (CG).

Graft technique

Under general anesthesia, bilateral transfemoral access was obtained via surgical cutdown, and 6F short sheaths (Terumo Europe) were placed in both of the common femoral arteries. The left brachial artery was then cannulated under ultrasound guidance with a 7F 90 cm Shuttle sheath (Cook Inc.). The patient was heparinized and activated clotting time was kept at 250–300 s. ARA was accessed with a 0.035-inch guidewire (Glidewire; Terumo Europe) and a 5F Headhunter catheter (Boston Scientific) via transbrachial approach. We tried to advance the catheter over the wire into ARA, but multiple attempts failed despite a number of different catheters and wires used.

After transbrachial deployment of CG failed, an IRPG was planned via transfemoral approach. A 24F sheath (DrySeal, W.L. Gore & Associates Inc.) was placed over a 300 cm ex-

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Received 1 September 2014; revision requested 8 October 2014; final revision received 28 December 2014; accepted 30 December 2014.

Published online 8 May 2015.
DOI 10.5152/dir.2014.14358

tra-stiff guidewire (Lunderquist, Cook Inc.) via right femoral artery. Through the 24F sheath, a 7F 55 cm guiding sheath (Cook Inc.) was advanced next to the extra-stiff wire. Through the guiding sheath, left ARA was cannulated using a 5F Cobra catheter (Glidecath, Terumo Europe) and a guidewire (Glidewire, Terumo Europe). Guiding sheath was advanced to the proximal ARA after guidewire was exchanged with a 0.035-inch 260 cm Amplatz super-stiff wire (Boston Scientific). A 6×150 mm covered stent (Viabahn, W. L. Gore & Associates Inc.) was positioned using the guiding sheath, and then the extra-stiff wire was removed.

A 30 mm stent-graft (Zenith Flex, Cook Inc.) was introduced via left femoral artery. After deployment of the main body, covered stent was released. Then, a second covered stent (6×100 mm Viabahn) was positioned with the distal end in the distal right CIA, but was not deployed. Subsequently, contralateral limb of the main body was cannulated and an 18×56 mm limb extension was introduced next to the covered stent. First, contralateral limb and then the covered stent were deployed. Since distal end of the covered stent was placed 15 mm below the iliac limb extension as an unintended consequence, a second 18×76 mm limb extension was deployed to position the distal end of extension 2 mm proximal to the covered stent. Thereafter, a 13×56 mm ipsilateral limb extension was deployed. After deployment of the limb extension and IRPG, they were post-dilated with kissing balloon angioplasty (6 mm balloon for periscope graft and aortic balloon for limb extension). Angioplasty was not performed to the proximal part of the main graft. At the end of the procedure, peak systolic pressure gradient (3 mm Hg) of the IRPG measured with an end-hole catheter was nonsignificant. The final angiogram revealed patent grafts without endoleak (Fig. 2). The whole procedure took two hours.

The patient fully recovered and was routinely discharged three days later, on dual antiplatelet therapy (300 mg acetylsalicylic acid and 75 mg clopidogrel). At three-month follow-up, CT angiography revealed a patent aortic stent-graft with a patent IRPG without endoleak (Fig. 3). Doppler ultrasonography demonstrated normal arterial resistivity (RI) and pulsatility indices (PI) of upper pole (RI, 0.70; PI, 1.44) and lower pole (RI, 0.65; PI, 1.36) of the left kidney, and

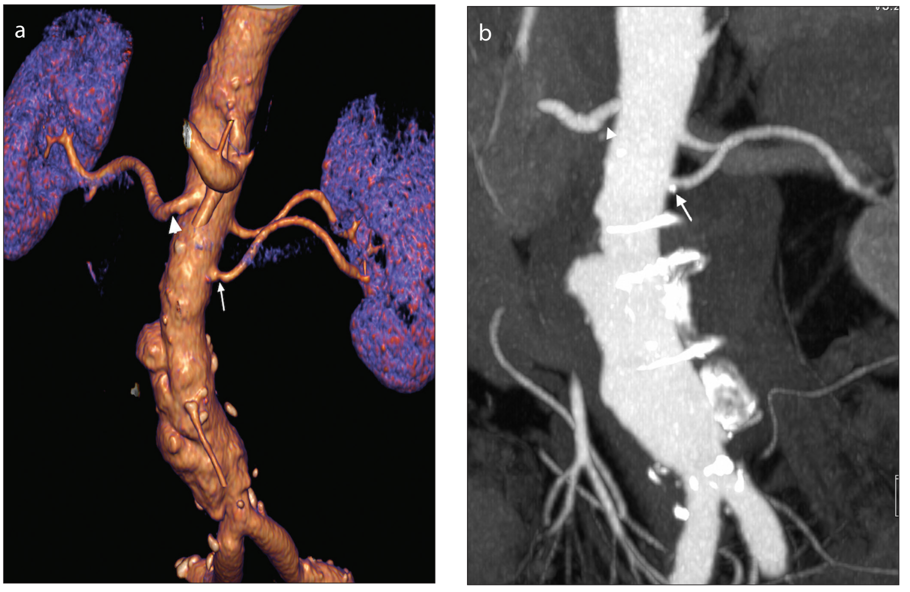

Figure 1. a, b. Preoperative three-dimensional volume-rendered **(a)** and maximum intensity projection **(b)** images show left accessory renal artery supplying half of the left renal parenchyma as well as both renal arteries. Note the nonsignificant stenoses due to fibrocalcific plaque at the proximal segment of the left accessory *(arrow)* and right main *(arrowhead)* renal arteries.

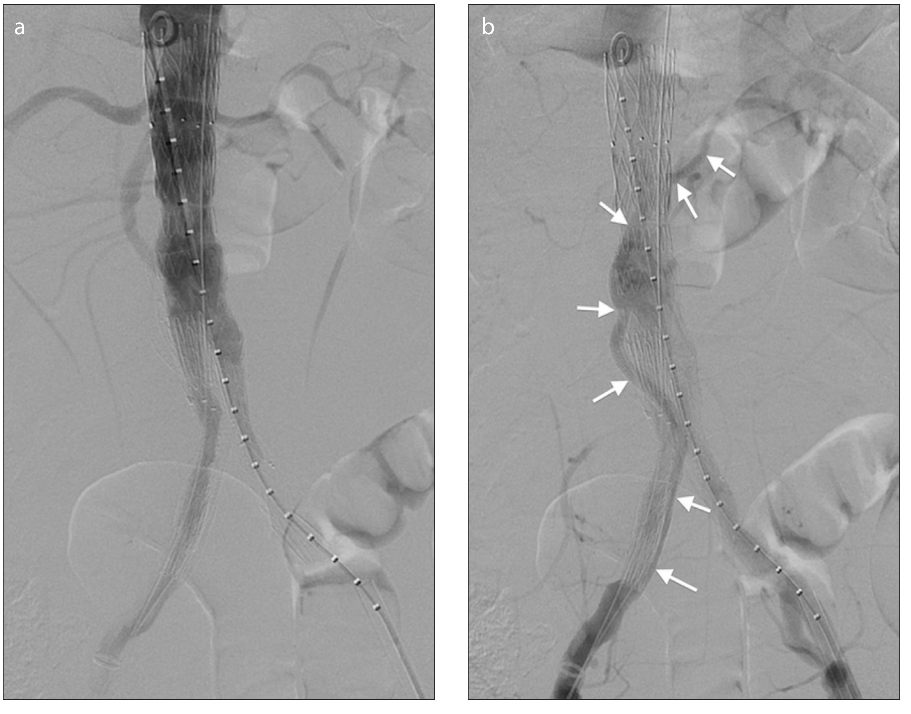

Figure 2. a, b. Early **(a)** and late **(b)** arterial phases of digital subtraction angiography obtained after deployment of aortic stent-graft and iliorenal periscope graft show appropriate position of the grafts, patent left accessory renal artery, and no filling of the aneurysm. Note the filling of the left accessory renal artery *(arrows)* in the late arterial phase.

Main points

- Endovascular aortic repair has become an established method for the treatment of abdominal aortic aneurysms.
- Periscope graft technique is similar to chimney graft, but in which the graft is reversed and blood flow to the branched artery is retrograde allowing extension of distal landing zone.
- Iliorenal periscope graft (IRPG) technique was used to maintain blood flow to the accessory renal artery in a retrograde fashion in a patient with unfavorable vessel anatomy for transbrachial access.
- The IRPG seems to be a useful technique to maintain accessory renal artery blood flow with off-the-shelf devices in case of transbrachial access failure.

Figure 3. a, b. Three-dimensional volume rendered **(a)** and curved multiplanar reconstruction **(b)** images obtained at the postoperative third month show a patent iliorenal periscope graft *(arrows)* placed from the left accessory renal artery to the right common iliac artery, as well as a patent aortic stent-graft. Left accessory renal artery flows were provided by iliorenal periscope graft in a retrograde fashion without endoleak.

the right kidney (RI, 0.65; PI, 1.31). Preoperative and three-month follow-up creatinine levels were 1.10 mg/dL and 1.18 mg/dL, respectively.

Discussion

To the best of our knowledge, a technique like ours to protect an ARA has not been published yet. We have used the IRPG technique to maintain blood flow to ARA in a retrograde fashion in a patient with unfavorable vessel anatomy for transbrachial CG. In the largest study with the longest follow-up relating to ARA coverage, Greenberg et al. (4) reported that although renal infarctions occurred in 84% of kidneys with covered ARAs, there was no significant deterioration in long-term glomerular filtration rate when compared with patients in the control group. In another study on the outcome of exclusion of ARA during endovascular repair in 24 AAA patients, Aquino et al. (5) documented that segmental renal infarction was noted by 21%, and one patient with segmental infarction had significant new-onset hypertension. Both studies showed that, protection of ARA should be considered in patients with renal disease, accessory arteries that perfuse more than one third of the renal parenchyma, and patients with adequate proximal landing zone. Since our patient had a large ARA that supplied half of the left renal parenchyma, we decided to protect it.

There are several technical considerations for IRPG. First, we deployed a covered stent as an IRPG to exclude type-Ib endoleak and selected Viabahn among covered stents due to its flexibility and availability in different lengths (2.5–25 cm) and sizes (5–13 mm). In addition, since the distance from the renal artery to iliac bifurcation is too long, Viabahn seems like the only option for IRPG technique for now. Other issues are iliac artery diameter and end-organ ischemia. A 14 mm CIA diameter enabled us to perform PG without type-Ib endoleak. Limb extension was oversized to minimize the probability of endoleak, so we used 18 mm instead of 14 or 16 mm; IRPG perfectly adapted within the iliac artery at this size. Pecoraro et al. (6) indicated that flow through PG might be restricted especially in PG ≤16 mm and might lead to end-organ ischemia. In our case, peak systolic pressure gradient was measured within IRPG and flow restriction was not detected. Wu et al. (7) has recently reported "crossover chimney technique" to preserve the contralateral internal iliac artery, which is similar to our technique in terms of placement of the distal end of Viabahn in CIA. In their report, a CG-related endoleak or occlusion and lower limb ischemia have not been observed up to six months. On the other hand, the authors did not measure peak systolic gradient for organ ischemia or indicate a lower limit for CIA diameter. No precise minimal CIA diameter has been proposed to place PG within the iliac artery without end-organ ischemia, and further studies are required.

Major advantage of the IRPG technique is that it can be applied in most anatomies, including emergency events, using conventional endovascular aortic repair devices that are universally available. Thus, this technique can even be employed in most centers performing endovascular aortic repair with CG and/or PG experience. However, the long length of the PG may be a potential hazard for kinking, thrombosis, and development of endoleak. IRPG technique has only short-term imaging and functional follow-up. In addition, although fenestrated graft seems to be a more suitable treatment solution than IRPG to salvage ARA for this patient, it has restricted availability in our country because of current reimbursement policies.

In conclusion, our experience showed that the IRPG can be a useful technique to maintain ARA blood flow with off-the-shelf devices in case of transbrachial access failure. Further studies are required to assess the long-term durability of IRPG.

Conflict of interest disclosure

The authors declared no conflicts of interest.

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