Total endovascular solution for complex visceral aneurysms

Fabio Verzini, MD, PhD, FEBVS,[a] Antonella Biello, MD,[a] Alessandro Marucchini, MD,[a] Basso Parente, MD,[a] Gianbattista Parlani, MD,[a] and **Piergiorgio Cao, MD, FRCS,[b]** *Perugia and Rome, Italy*

Visceral aneurysms are rare in the general population (<2%), and the most serious complication is represented by aneurysm rupture. The use of stent grafts to exclude visceral aneurysms is described in several reports but is reserved for patients with favorable anatomy. We report here on a hepatic artery pseudoaneurysm in a liver transplant patient and a patient with an aneurysmal vein graft degeneration of a renal bypass, both with no suitable proximal neck for standard stent grafting. Both patients were successfully treated with a custom-made aortic endograft with a single fenestration for the hepatic or renal artery, together with a visceral covered stent. Although initial results are promising, long-term follow-up is required to assess durability. (J Vasc Surg 2013;58:1412-6.)

Visceral artery aneurysms, both true and pseudoaneurysms, are rare entities with an incidence at angiographic series and autopsy ranging between 0.1% and 2%.[1] The most serious complication is represented by aneurysm rupture, associated with patient mortality of 10% to 70% in most reported studies.[2-4] Surgical treatment is warranted in case of symptoms and when the risk of rupture is deemed high, depending on aneurysm size, location, etiology, and associated conditions. False aneurysms may be at a higher risk of rupture due to the lack of a continuous adventitial layer in the outer wall. Aneurysms developing after previous surgical treatment offer an extreme surgical challenge due to the presence of adhesions and the risk of iatrogenic injuries and intraoperative rupture.

Several reports have described the successful use of stent grafts to seal visceral aneurysms, but they are usually reserved for few patients presenting with a favorable anatomy. The technique described in this report represents a novel solution for endovascular visceral aneurysm exclusion in the setting of vessel dilations with no proximal sealing zone at the level of the proximal aortic origin.

We report two cases of late development of aneurysmal evolution. The first case was a hepatic artery homograft in a liver transplant patient, and the second was a vein graft renal bypass. Both patients were treated with this endovascular option.

From the Unit of Vascular and Endovascular Surgery, Ospedale S. Maria della Misericordia, Università degli Studi di Perugia, Perugia[a]; and the Unit of Vascular Surgery, Department of Cardiosciences, Ospedale S. Camillo-Forlanini, Rome.[b]

Author conflict of interest: none.

Reprint requests: Fabio Verzini, MD, PhD, FEBVS, Unit of Vascular and Endovascular Surgery, Ospedale S. Maria della Misericordia, Piazzale Menghini, 1, 06132 Perugia, Italy (e-mail: fverzini@unipg.it).

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

0741-5214/$36.00

http://dx.doi.org/10.1016/j.jvs.2013.05.045

CASE REPORT

Patient 1. A 53-year-old man had an orthotopic liver transplant for end-stage liver disease secondary to cirrhosis. The donor iliac artery was used as a free arterial graft anastomosed to the recipient patient's abdominal aorta in an end-to-side fashion and end-to-end to the hepatic artery. After 20 years, the patient was doing well, with almost normal function liver tests, apart from a mild increase of serum aspartate aminotransferase and alanine aminotransferase. A contrast-enhanced computed tomography (CT) follow-up scan confirmed the presence of a 4-cm hepatic artery pseudoaneurysm, partially thrombosed extending for 6 cm in length from the aortic anastomosis to the distal hepatic artery, suspected at a routine echographic control (Fig 1).

To treat the aneurysm, which showed no proximal aneurysm neck suitable for a regular stent graft, a custom-made tubular aortic endograft (Cook Inc, Bloomington, Ind) with a single fenestration for the transplanted hepatic artery was designed. The procedure was done under local anesthesia in a hybrid operating room equipped with a fixed, ceiling-mounted, angiography machine with a flat panel. After a bilateral femoral cutdown, the aortic endograft was partially deployed into the infrarenal aorta, mating the fenestration with the dilated ostium of the visceral aneurysm. After wire cannulation of the fenestration and the aneurysmal hepatic artery through a femoral access, the aortic graft was fully expanded, and two covered Viabahn stent grafts (W. L. Gore and Associates Inc, Newark, Del) were deployed from the hepatic aneurysm neck. Proximally, a balloon-expandable Advanta V12 stent graft (Atrium, Hudson, NH) was deployed so that most of the stent was anchored within the Viabahn and ~5 mm of the proximal stent extended into the aorta through the fenestration. Flaring of the proximal (aortic) end of the stent was achieved with a 12-mm-diameter balloon.

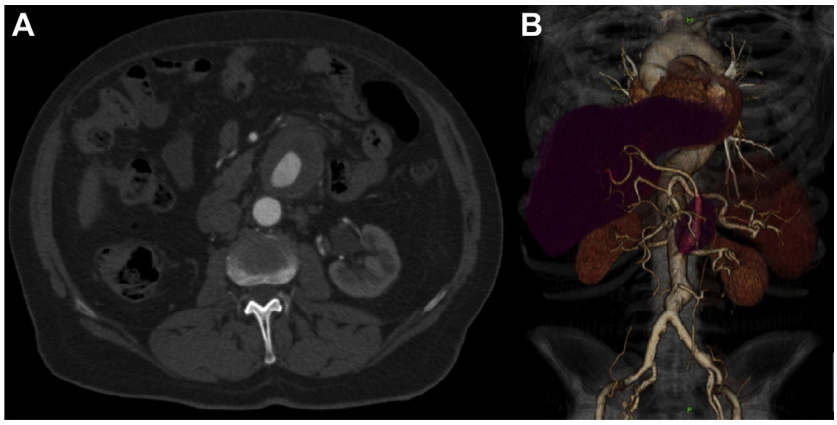

Fig 1. A, Axial computed tomography (CT) image shows a hepatic pseudoaneurysm at the proximal aortic anastomosis. **B,** A three-dimensional CT reconstruction illustrates the partially thrombosed (*red*) pseudoaneurysm.

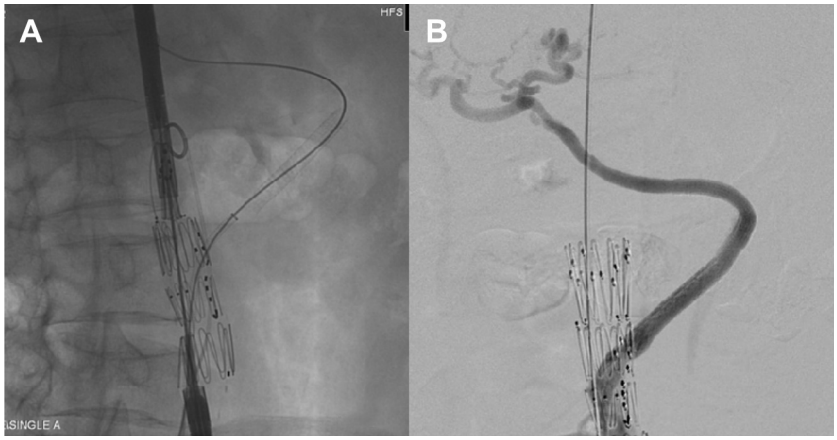

Fig 2. Intraoperative angiogram is shown **(A)** after partial deployment of a fenestrated aortic endograft and wiring of the transplanted hepatic artery through the fenestration and **(B)** a completion angiogram after aortic and hepatic endografting in the same patient as in Fig 1.

Completion angiogram showed patency of the aortic and hepatic endograft with no endoleaks (Fig 2).

The patient was discharged on postoperative day 4, without complications, on antiplatelet therapy. Duplex ultrasound imaging follow-up showed a normal hepatic flow pattern. A CT scan at 1 and 8 months showed a widely patent extrahepatic and intrahepatic artery and total exclusion of the pseudoaneurysm sac (Fig 3). At the 11-month follow-up, liver function tests were within normal reference ranges, and a duplex ultrasound scan confirmed aneurysm exclusion and regular flow to the hepatic artery.

Patient 2. In 1973, a 19-year-old woman had an aortorenal bypass with reversed saphenous vein graft for fibromuscular dysplasia. When she was 55, a duplex ultrasound follow-up scan revealed aneurysmal degeneration of the vein graft, with a maximum diameter of 4 cm (Fig 4). Because the aneurysm presented a suitable distal landing zone but a dilated aortic origin, a custom-made aortic endograft (Cook Inc) was designed with a single fenestration for the aneurysm of the renal artery. The aortic endograft was deployed with general anesthesia and single femoral cutdown. Two covered Advanta stent grafts were then deployed from distal to proximal through the fenestration to exclude the renal aneurysm, and the proximal end was flared to reinforce the proximal sealing at the level of fenestration. An intraoperative angiogram showed patency of aorta and renal artery with no endoleaks.

The patient was discharged after 2 days, and no perioperative complications were recorded. Renal function was normal, with a creatinine serum level of 0.9 mg/dL. During the following 3 years, duplex ultrasound and CT examinations confirmed persisting patency of the stent grafts and renal aneurysm exclusion (Fig 5). Serum creatinine levels remained within normal reference ranges.

DISCUSSION

The incidence of hepatic artery pseudoaneurysm is 1% to 2% in all liver transplant patients[5,6]; standard surgical treatment is associated with mortality rates as high as 69%. The development of aneurysm degeneration of previous aortorenal saphenous vein bypasses is even more

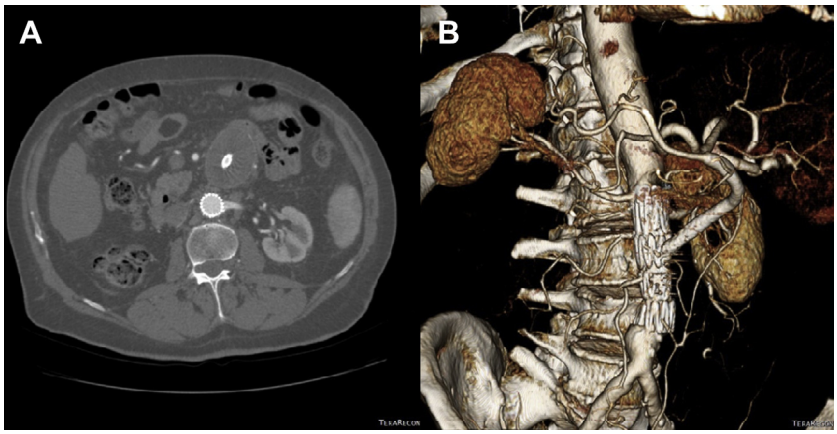

Fig 3. A, An axial computed tomography (CT) image in the same patient as in Fig 1 after 8 months from treatment shows patency of aortic and hepatic endograft in the absence of endoleak. **B,** A three-dimensional reconstruction of the same CT scan shows additional details.

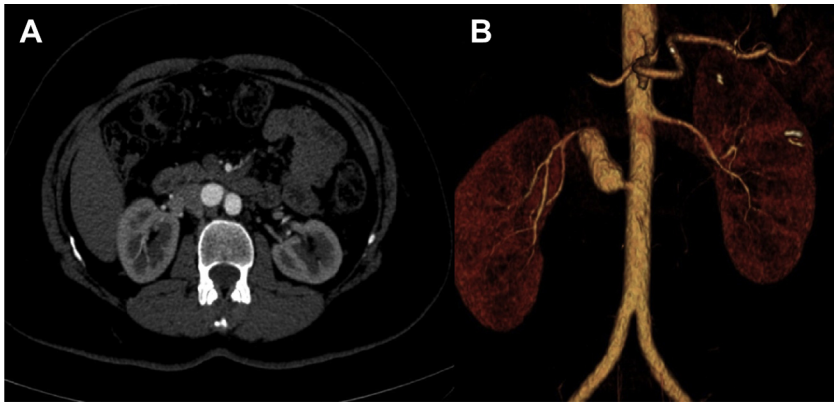

Fig 4. A, An axial computed tomography (CT) image shows vein graft aneurysmal degeneration. **B,** A three-dimensional CT reconstruction illustrates the vein graft aneurysm.

rare. In a review of 278 aortorenal grafts published in 1985, Stanley et al[7] reported three (1%) such patients, all requiring surgical revision.

Endovascular treatment may offer several advantages compared with traditional surgical repair due to its minimal invasiveness. Coil embolization of the aneurysm is usually technically feasible in saccular aneurysms, but the risk of coil migration still remains a concern.[8] Early recanalization of the aneurysm can occur.

Exclusion of aneurysm or pseudoaneurysm by endovascular grafts has been increasingly adopted, as highlighted in current reports.[9-13] Covered stents offer the advantage of a minimally invasive treatment, maintaining vessel patency and end-organ perfusion, but there are often contraindications because of the patient's arterial anatomy. Requirements for stent grafting are the presence of suitable sealing zones proximally and distally to the aneurysm, the absence of a critical vessel takeoff from the aneurysm sac to be excluded, and an arterial access that permits safe navigation of the stent graft deployment system to the target location. With these requirements, treatment of visceral aneurysms secondary to organ transplants or previous visceral bypass often entails challenging open surgical solutions.

Even in the most recent published reports, the favored endovascular treatment option for visceral aneurysms is still characterized by coil or glue exclusion, often associated with feeding vessel obstruction.[9-13] In a three-center experience from the Mayo Clinic reporting 185 aneurysms treated during a 10-year period, simple endovascular coiling represented the sole treatment in 78%, and covered stent alone was used in 5%. Fankhauser et al[10] reported a 30-day mortality rate of 6.2%, due to bleeding in half of the patients.

In the present patients, to create a proximal sealing zone for the stent graft in visceral aneurysms with a dilated aortic origin, a custom-made aortic endograft with a single fenestration for the hepatic or renal aneurysmatic artery was designed and placed into the aorta. In both patients, a 6-mm circular fenestration was used, mating the visceral

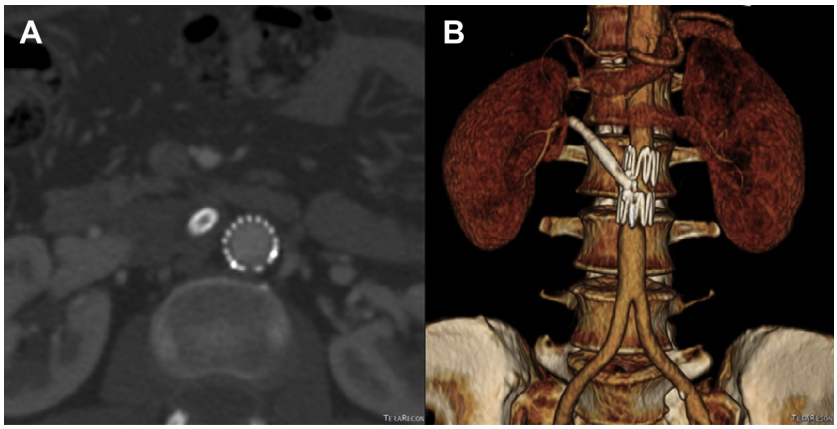

Fig 5. A, An axial computed tomography (CT) image in the same patient as in Fig 4 after 31 months from treatment shows patency of aortic and renal endograft in absence of endoleak. **B,** A three-dimensional reconstruction of the same CT scan shows additional details.

vessel diameter distal to the aneurysm. For construction constraints, possible fenestration diameters can range between 6 and 8 mm, without the risk of a stent strut crossing the fenestration. The location should be placed at least 15 mm away from the end of the graft. The aortic component is usually chosen with an oversize of 10% compared with the aortic diameter and with a total length of at least 40 mm to accommodate two aortic stents.

To seal the visceral aneurysm, precise deployment of a single stent graft of the exact length needed is rarely possible; therefore, a better solution of two stents partially overlapping may be more useful. Of note, the preferred proximal stent graft should be a balloon-expandable covered stent that can be flared with an oversized balloon to enhance fixation and sealing. In case of vessel tortuosity, the distal segment may be represented by a more flexible self-expanding stent graft.

This technique has limitations due to anatomic constraints. The use of an aortic endograft requires large-bore introducer systems and suitable iliac access arteries. There must be an aortic sealing zone for the fenestrated graft proximally and distally to the fenestration of at least 15 mm in length; otherwise, a multiple fenestration graft could be used. Absolute contraindication to this endovascular treatment is aneurysm rupture or the need of urgent treatment in which time delay to obtain a suitable fenestrated endograft cannot be tolerated.

Other contraindications are represented by patient intolerance to stainless steel, nitinol, gold, polyester, polypropylene, or medium contrast. Moreover, patients with septic aneurysms or high septic risks might be better addressed by open surgical repair with autogenous grafts.

In our experience, aneurysm exclusion and end-organ perfusion was successfully obtained in both patients in the midterm, without postoperative complications and with a short hospital stay. Our patients were treated indefinitely with single antiplatelet therapy with 100 mg/d of acetylsalicylic acid and followed up with duplex ultrasound imaging before hospital discharge and every 6 months thereafter. A CT scan was scheduled at 1 month and yearly postoperatively.

CONCLUSIONS

Endovascular visceral aneurysm exclusion with aortic fenestrated endograft coupled with visceral covered stent may represent a favorable treatment option for patients without a suitable proximal neck. Although the initial results are promising, a longer follow-up is required to assess the durability of repair.

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Submitted Feb 27, 2013; accepted May 10, 2013.