Covered endovascular repair of the paravisceral aorta

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ABSTRACT

Open aortic repair is considered the "gold standard" treatment for aortic occlusive disease. We present the case of an 83-year-old patient with refractory hypertension caused by paravisceral aortic stenosis including both renal arteries and the superior mesenteric artery. We planned an endovascular approach and treated the patient with parallel stent grafts in the paravisceral aorta. At 1.5 years after the operation, the patient was free of hypertensive episodes. Covered endovascular repair of the paravisceral aorta may be a valuable alternative to open aortic repair in patients unfit for open surgery. More research is needed to evaluate the long-term effects of this technique. (J Vasc Surg Cases and Innovative Techniques 2017;3:188-91.)

Endovascular treatment in abdominal aneurysm repair has been firmly established, yet its application in aortic occlusive disease has been limited.[1] Coral reef aorta is a rock-hard calcification of the paravisceral aorta that often narrows the lumen to a few millimeters in diameter. Whereas open aortic repair is considered the "gold standard," recent publications have illustrated the possible use of endovascular therapy in aortic occlusive disease.[2,3] The involvement of the visceral arteries complicates endovascular repair because of the danger of overstenting, and the small remaining aortic lumen prohibits the use of branched or fenestrated grafts.

In 2013, Bin Jabr et al[4] proposed the use of chimney grafts to protect the visceral branches during stenting of juxtarenal occlusive disease. We used a combination of chimney and snorkel grafts to treat a patient with extensive paravisceral aortic occlusive disease.

We received the patient's written consent to publish the case.

CASE REPORT

An 83-year-old woman was admitted to our emergency department with nausea, headache, and blood pressure readings of 245/120 mm Hg in the right arm and 150/100 mm Hg in the left arm. Anamnesis revealed a history of refractory hypertension with an episode of hypertensive pulmonary edema and chronic renal failure. An ultrasound investigation after the patient's pulmonary edema had revealed bilateral renal artery (RA) stenosis. At the time of diagnosis, the patient had refused open surgical management.

Serum creatinine concentration was 2.1 mg/dL (estimated glomerular filtration rate [eGFR], 24 mL/min) at admission. Clinical imaging revealed the pararenal aorta to be heavily calcified over a length of 25 mm, including the origin of both RAs and the superior mesenteric artery (SMA), as well as a chronic occlusion of the celiac trunk (Fig 1). The right RA was a small-diameter vessel with a weak perfusion signal, and the right kidney showed severe cortical atrophy. The left RA was a 5-mm vessel with a singular stenosis at the artery's origin. Peak systolic velocity measured in the left RA was 366 cm/s, equivalent to a stenosis >60%. The aortic lumen at the encircling occlusion was reduced to 3 mm in diameter.

An initial pulse examination showed palpable femoral and radial pulses with a distinct difference between the left and right radial pulses and no palpable pedal pulses. The difference in blood pressure readings between both arms was consistently between 60 and 80 mm Hg systolic pressure. The ankle-brachial index before the procedure was 0.82 on the left and 1.0 on the right, with minimal pulse wave amplitudes. The patient had no symptoms of claudication in the lower extremities.

Because of the patient's age, chronic renal failure, history of pulmonary edema, and objection to an open surgical approach, possibilities of an endovascular repair were explored.

The internal medicine consultant ranked the patient at American Society of Anesthesiologists class 3 and found the patient fit for endovascular aortic repair. The European System for Cardiac Operative Risk Evaluation (EuroSCORE) and the Revised Cardiac Risk Index put the patient in the "high" risk bracket. The difference in blood pressure readings was caused by a left subclavian artery stenosis. A reversal of flow in the left vertebral artery was observed (third-degree subclavian steal).

Three goals were identified: salvage of the SMA, repair of the left RA stenosis, and augmentation of the aortic lumen. Because of the loss of right kidney function, revascularization of the right RA was not indicated. It was concluded that a combined chimney and snorkel technique would be feasible to fulfill these aims.

OPERATIVE MANAGEMENT

General anesthesia was induced, and the patient was placed in a supine position. Cannulation of the SMA

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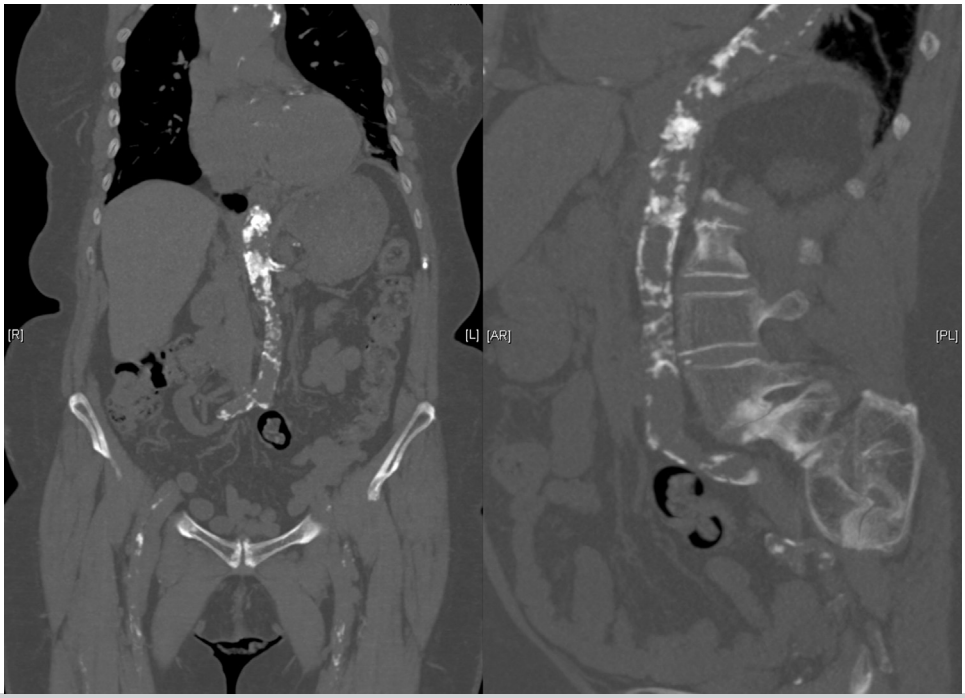

Fig 1. Preoperative computed tomography imaging of the aortic stenosis encompassing the origins of both renal arteries (RAs) and the superior mesenteric artery (SMA). *Left*, Coronal plane. *Right*, Sagittal plane.

was accomplished through a right subclavian artery approach, and the left RA was accessed through the right common femoral artery. After angiographic validation of correct catheter placement, semistiff Rosen wires were positioned in the target vessels. A stiff wire was positioned in the aortic lumen through the left common femoral artery. A 7- × 59-mm Advanta V12 stent graft chimney (Maquet-Atrium Medical Inc, Hudson, NH) was placed in the SMA, a 12- × 61-mm Advanta V12 stent graft was placed at the site of the aortic stenosis, and a 7- × 59-mm Advanta V12 stent graft snorkel was positioned in the left RA.

The chimney-tube-snorkel combination was successfully deployed by concomitant inflation of the three balloons. Because of kinking of the left RA snorkel, the stent graft was lined with an 8- × 60-mm Bard ELuminexx stent (Bard Peripheral Vascular Inc, Tempe, Ariz).

Intraoperative angiography showed technical success with an enhanced perfusion of the left RA as well as of the SMA and the aorta (Fig 2).

The patient suffered no perioperative complications. The postoperative pulse examination was identical to the preoperative one, and we were able to reduce the patient's antihypertensive therapy. The ankle-brachial index half a year after the procedure was not measurable on the left and 0.56 on the right, with minimal pulse wave amplitudes at the ankle both before and after the procedure. The patient had no symptoms of claudication in the lower extremities. From admission until discharge (28 days), 40 mg of low-molecular-weight heparin and 100 mg of aspirin were administered once daily. The serum creatinine concentration dropped to 1.3 mg/dL (eGFR, 42 mL/min) on the second postoperative day. At computed tomography angiography performed after the procedure, the right RA held slight traces of contrast fluid, whereas the left RA showed no significant stenosis (Fig 3).

After an uneventful stay, the patient was discharged home 2 weeks after the operation.

A month after the operation, the patient had a subacute ischemic right posterior stroke. The main symptom was left homonymous hemianopia. Because of the known subclavian steal syndrome and significant stenosis at the origins of both vertebral arteries, the diagnosis of our neurology department was an insufficient perfusion of the circle of Willis. We recommended open surgical repair, which the patient declined. Her anticoagulation was changed from aspirin 100 mg daily to clopidogrel 75 mg daily.

At 18 months after the operation, the patient was free from symptomatic hypertensive episodes and neurologic events, but the serum creatinine concentration had increased to 1.6 mg/dL (eGFR, 32 mL/min) after 3 months and 2.1 mg/dL (eGFR, 24 mL/min) after 18 months. The patient is now scheduled for yearly follow-up.

DISCUSSION

Endovascular repair of aortic aneurysms has become an established technique and is associated with increased short-term survival and quality of life.[5,6] The minimally invasive nature of endovascular aortic repair makes it more viable for patients with higher overall morbidity.[7]

Aortic occlusive disease is commonly treated by open repair. The treatment of distal aortic stenosis by "kissing"

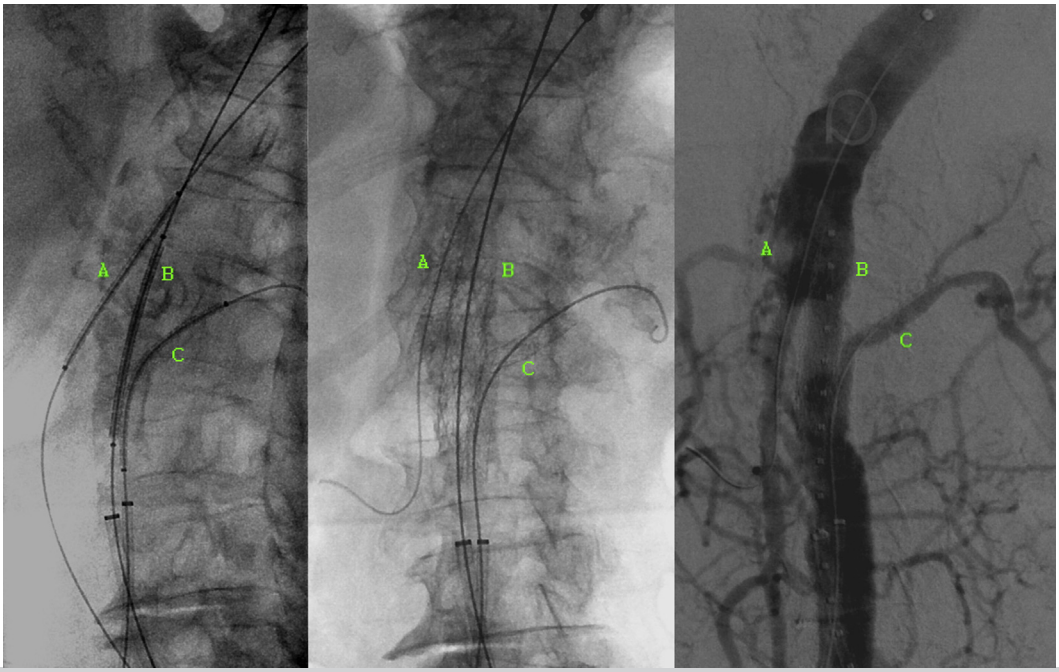

Fig 2. Intraoperative angiography of the paravisceral aorta. The stent grafts have been positioned (*left*), deployed (*middle*), and pictured by contrast fluid angiography (*right*) in the **(A)** superior mesenteric artery (SMA), **(B)** abdominal aorta, and **(C)** left renal artery (RA).

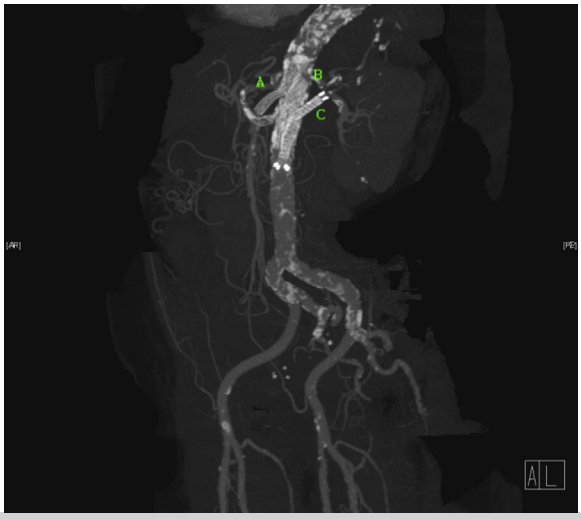

Fig 3. Postoperative computed tomography angiography three-dimensional reconstruction of the abdominal aorta showing the stents in the **(A)** superior mesenteric artery (SMA), **(B)** abdominal aorta, and **(C)** left renal artery (RA).

stents was first described in 1991 by Palmaz et al.[8] In 2013, Goverde et al[9] introduced covered endovascular reconstruction of the aortic bifurcation (CERAB), aiming to overcome the difficulties of kissing stent grafts by creating a neobifurcation using a main body and two iliac branches. Grimme et al[10] treated 103 patients suffering from obstructive disease of the aortic bifurcation using the CERAB technique and concluded that the CERAB technique is a safe and feasible alternative to open surgical reconstruction of the aortic bifurcation in complex aortoiliac occlusive disease. Whereas there are no prospective, randomized data comparing open repair and endovascular repair in aortic occlusive disease, endovascular repair may provide an opportunity to treat patients who are unfit for open surgery.[4,11]

Endovascular repair of juxtarenal aortic occlusive disease proves to be especially challenging because of the danger of impairing the integrity of visceral arteries. The dominance of open surgical repair may be caused by limited available techniques for endovascular repair when patients suffer from aortic occlusion that includes paravisceral arteries.[2,3]

In 2013, Bin Jabr et al[4] treated 10 patients suffering from juxtarenal aortic occlusion using chimney grafts to protect the patency of the visceral arteries during aortic stenting. In accordance with the cases described by Bin Jabr et al, our patient was an elderly woman whose comorbidities put her at high risk for open surgical repair. An extra-anatomic, axillofemoral bypass would have failed to improve the patient's visceral perfusion.

As shown in the Performance of the Chimney Technique in the Treatment of Pararenal Pathologies (PERICLES) registry, chimney endovascular aneurysm repair is associated with a risk of type Ia endoleaks, a result of gutters forming between the main stent graft and the chimneys.[12] The technique we used is not designed to cover the whole circumference of the aorta, preventing blood flow alongside the stents, as would be required in aortic aneurysm repair. This constitutes

the technique's main drawback: the missing ability to contain a potential aortic rupture. During the balloon inflation of the stents, dislodged plaques could perforate the aorta, requiring emergency open repair.

Because of the greater radial force applied during deployment, we chose balloon-expandable stents over self-expanding stents for this procedure.[3] With an aortic diameter of 25 mm above and 18 mm below the stenotic lesion and a diameter of 3 mm at the level of the stenosis, the cross-sectional profile was limited. Therefore, we decided to orient the parallel grafts to provide blood flow to the intestines and the left kidney in altering directions. We chose the diameter of the stent grafts as large as possible according to the diameter of the target vessels and the aortic profile below and above the lesion. Concerning the main body, we did not plan to exceed 9F when choosing the deployment device because of the diameter at the level of the stenosis.

More research is needed to evaluate the technique's long-term effects and possible complications, such as restenosis, migration of the stents, and stent compression.

To standardize the nomenclature for endovascular repair of aortic occlusions including visceral arteries, we propose the term *covered endovascular repair of the paravisceral aorta* (or CERPA), which may be considered a valuable alternative to open repair in patients unfit for open surgery.

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