Transarterial embolization of a large high-flow right renal arteriovenous fistula using stents and an across-stent wire-trapping technique

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ABSTRACT

Renal arteriovenous fistulas (AVFs) are rare vascular abnormalities. Their high-flow nature may result in increased cardiac output and lead to heart failure. Transcatheter endovascular management of renal AVFs with various embolization materials has been the treatment of choice in recent years. Embolization of large renal AVFs poses a risk of embolization through the AVF to the pulmonary circulation. Herein, we present the case of a patient whose large high-flow renal AVF was treated by a novel method involving the use of a bare stent and detachable metallic coils—called a wire-trapping technique—as well as compare this method with vascular plugs. (J Vasc Surg Cases and Innovative Techniques 2019;5:122-7.)

Keywords: Transcatheter embolization; Arteriovenous fistula; Across-stent wire trapping

High-flow renal arteriovenous fistulas (AVFs) are rare vascular abnormalities[1] that may lead to heart failure.[2-5] Endovascular management of renal AVFs has been the treatment of choice in recent years,[6-10] but treatment of a large, high-flow AVF involves the risk of migration of the coils through the AVF with embolization to the lungs. Many embolization materials and techniques have been used, and vascular plugs have been recommended in some studies.[10-13] We describe a novel method for the treatment of large high-flow renal AVFs performed using a self-expanding bare-metal stent and detachable metallic coils—called a wire-trapping technique—and compare this method with the technique using vascular plugs.

CASE REPORT

A 52-year-old woman visited our hospital because of soreness of the right side of the back for 1 year, shortness of breath for 1 to 2 years, and abdominal fullness for the previous 1 to 2 months. She denied a history of surgical procedures or interventions related to her right kidney, had no history of trauma, and had no hereditary disease or family history. Ultrasound examination revealed an anechoic space-occupying lesion at the right renal hilum. Computed tomography showed a right renal AVF (Fig 1) with moderate cardiomegaly. The arteriovenous connection, including dilated feeding artery and drainage vein, measured 11 to 26 mm in diameter (average, 15 mm). Echocardiography revealed a 41% left ventricular ejection fraction. Renal AVF with borderline heart failure was diagnosed. Therefore, the patient was referred to our vascular surgery department and selected endovascular treatment after discussion with the medical staff; the treatment was to be performed by a combination of cardiovascular surgeons and radiologists. The patient provided written consent for images and written descriptions of this case to be used for academic purposes.

Initial angiography of the right kidney revealed a high-flow AVF (Fig 2) and enlarged right renal artery, right renal vein, and inferior vena cava. The first transarterial embolization with coils plus attempts of arterial and venous flow control failed because of balloon migration and unsuccessful coil anchoring.

Another transarterial embolization trial was performed later under general anesthesia and intubation. Solitary accesses to the right common femoral artery and right common femoral vein were individually established through ultrasound-guided punctures. A through-and-through wire was set up through the right common femoral artery-right renal artery through the AVF to the right renal vein-right common femoral with gradual exchange to a 0.035-inch stiff wire (Terumo, Tokyo, Japan). An 8F Flexor Shuttle guiding sheath plus Check-Flo hemostasis assembly (Cook Medical, Bloomington, Ind) was advanced by the through-and-through wire until the tip was in the right renal artery. A 14- to 60-mm LifeStar stent (Bard, Murray Hill, NJ) was deployed at the AVF as a barrier and filter under venous flow control by Coda balloon (Cook Medical). Two Progreat microcatheters (Terumo) were placed outside the stent, and a VER catheter (Cook Medical) was advanced in the stent (Fig 3, *A*) simultaneously through the 8F guiding sheath. The blood leakage from the guiding sheath with three

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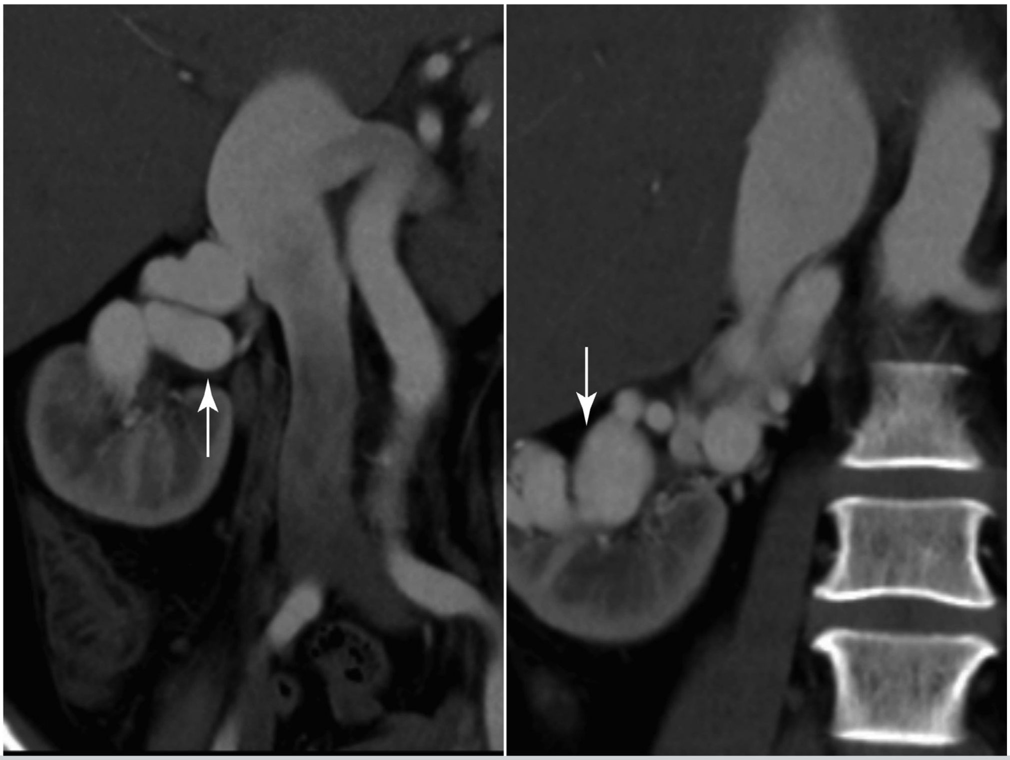

Fig 1. Coronal computed tomography angiography image showing a large tortuous right renal arteriovenous fistula (AVF; *arrow*) with engorged inferior vena cava.

Fig 2. Aortogram showing a large tortuous right renal arteriovenous fistula (AVF; *arrow*) with early opacification of inferior vena cava, indicating high flow.

catheters was greatly reduced by the check valve of the Check-Flo hemostasis assembly. We then performed an across-stent wire-trapping technique by advancing the third Progreat microcatheter through the VER catheter from inside the stent through the mesh into the outside of the stent and then again through the mesh to the inside, repeating once, then withdrawing the microcatheter and leaving a 0.018-inch Interlock-18 coil (Boston Scientific, Marlborough, Mass) in the route as a barrier to embolization of subsequent coils through the AVF. Subsequently, we deployed a 32- to 60-cm Ruby coil (Penumbra, Alameda, Calif) and a 14- to 20-cm Interlock-18 coil in the stent, which was trapped by the previously placed 0.018-inch metallic coil and successfully anchored in the stent (Fig 3, *B*). Multiple 0.035-inch Nester embolization coils (Cook Medical) were deployed in the stent, captured by and entangled with the previously placed Ruby coil and Interlock-18 coils, as many as possible. Then, we deployed multiple 0.018-inch VortX 18 coils (Boston Scientific) through the previously embedded

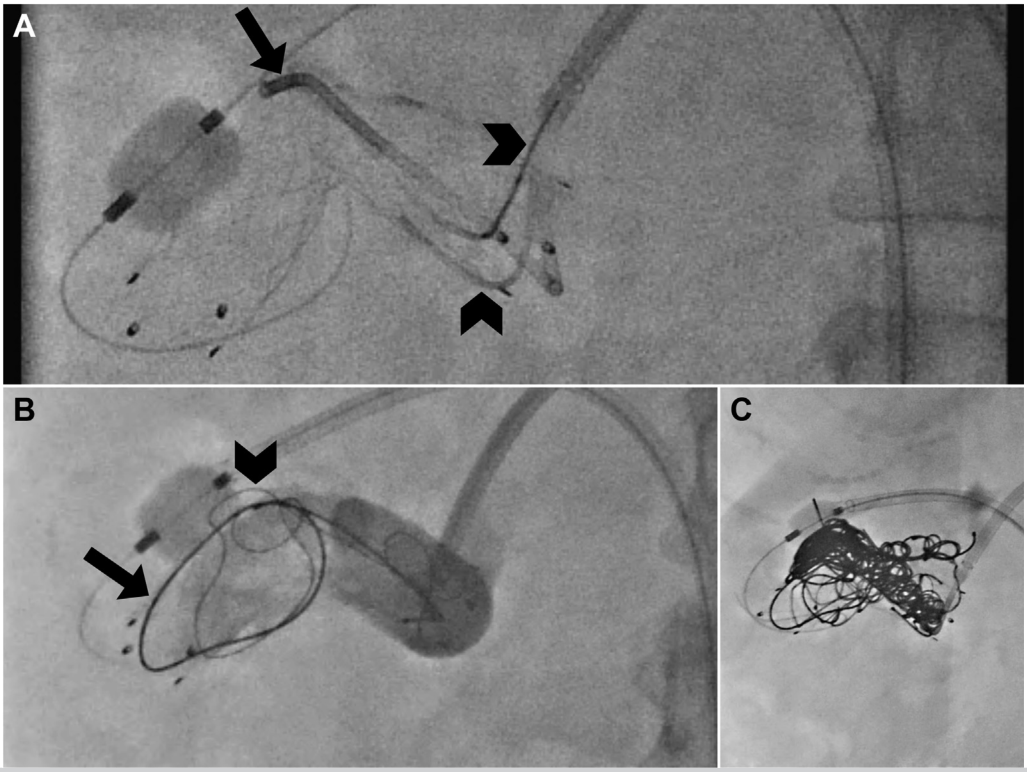

Fig 3. **A,** Right renal angiogram showing status after deployment of a bare-metal stent in the renal arteriovenous fistula (AVF), with a total of three catheters, including a VER catheter (*arrow*) for in-stent coil deployment and two Progreat microcatheters (*arrowheads*) for out-stent coil deployment. **B,** Contrast medium filling in the stent, indicating a 0.018-inch metallic coil out-in-out of the stent as a barrier (*arrowhead*) and a 0.035-inch metallic coil in the stent (*arrow*) trapped by the 0.018-inch coil. **C,** Multiple 0.035-inch metallic coils deployed in the stent and 0.018-inch metallic coils deployed outside the stent in the renal AVF, blocked by bare-metal stent without migration.

Fig 4. **A,** Final angiography. **B,** Follow-up computed tomography angiography showing complete occlusion of the arteriovenous fistula (AVF).

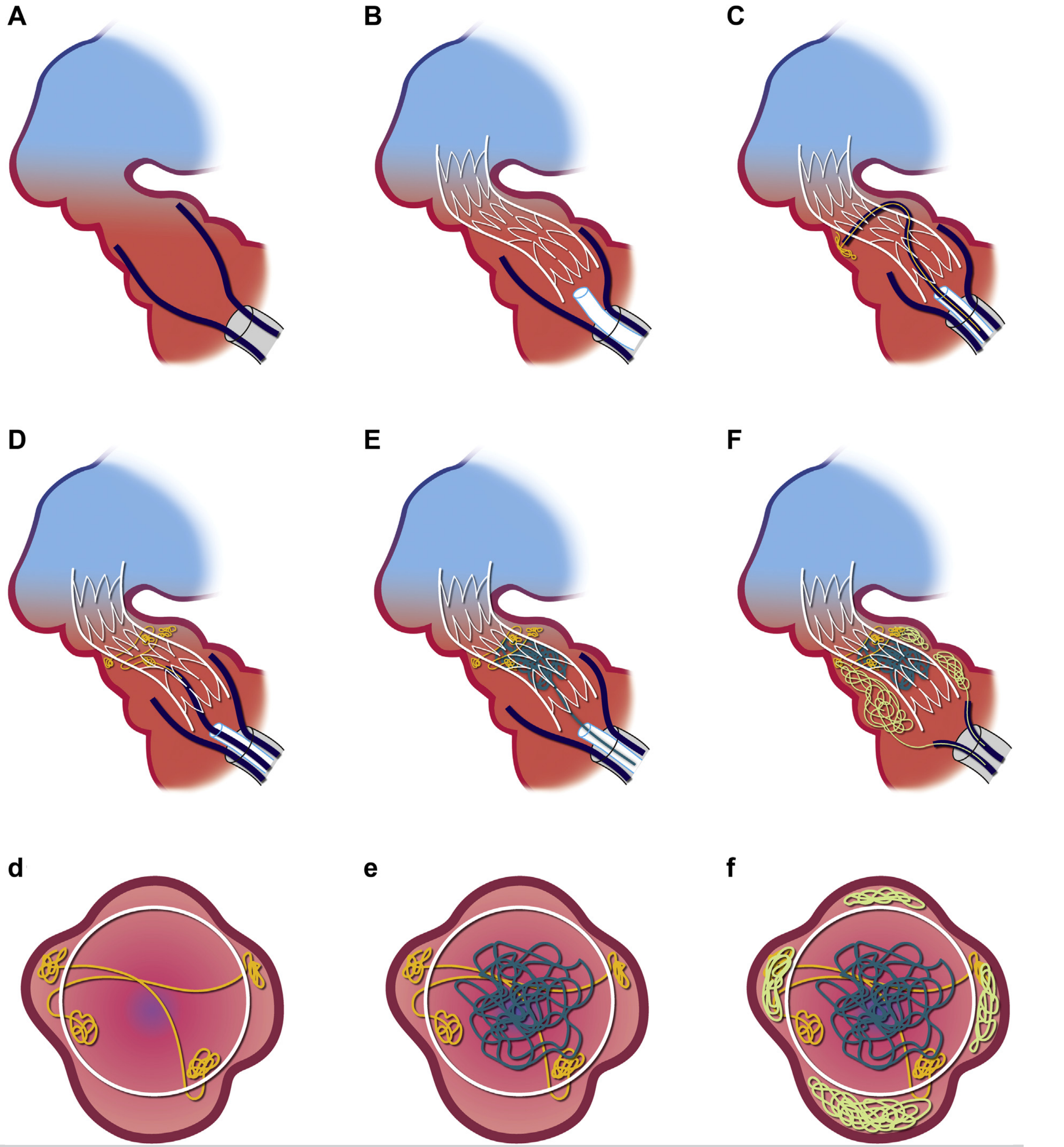

Fig 5. Step-by-step illustration of the wire-trapping technique. The *red area* indicates feeding branch of renal artery, and the *blue area* indicates drainage vein. **A,** Two preplaced microcatheters (*dark blue thin catheters*) from guiding catheter. **B,** Relationship of bare-metal stent and catheters, including two preplaced microcatheters and central VER catheter (*central midsized catheter*). **C,** Third microcatheter advanced from the VER catheter, through opposite sides of stent mesh. A 0.018-inch coil was deployed from this catheter and left in the path. **D,** After deployment of two 0.018-inch coils as in-stent barriers. **E,** Deployment of 0.035-inch coils in stent, entangled with in-stent barriers. **F,** Deployment of 0.018-inch coils outside the stent to fill the gap between stent and vessel. **d-f,** Demonstration of cross-sectional view corresponding to **D-F**.

Prograt microcatheters outside the stent to fill the gaps between the stent and AVF (Fig 3, *C*). Final angiography of the right kidney showed complete embolization of the fistula (Fig 4, *A*).

The patient recovered well with only temporary right flank soreness and was discharged 4 days later after the final embolization procedure. She reported relief of all her symptoms. Computed tomography angiography showed complete occlusion of the AVF, only estimated <10% renal parenchyma that was infarcted (Fig 4, *B*). Her renal function was within normal range without change before and after the embolization procedure. Her physical condition was continuously improved without recurrence of previous symptoms by the 10-month follow-up.

DISCUSSION

In recent years, superselective renal artery embolization has been the treatment of choice for renal AVFs.[10,11,14] With the development of catheterization techniques and embolization materials, the majority of renal AVFs can be treated with improved safety combined with a high success rate, fewer hospitalization days, and lower morbidity and mortality compared with conventional surgery.[11,15,16]

Numerous embolization materials have been used, including metallic coils, sclerosing liquid agents, particulate embolization materials, covered stents, and vascular plugs.[17] Several authors have recommended vascular plugs, specifically Amplatzer Vascular Plug 2 (AVP 2; St. Jude Medical, Plymouth, Minn), as the first choice to occlude high-flow renal AVFs.[10-12] These are self-expanding, cylindrical occluding devices with a diameter ranging from 3 to 22 mm that can be safely used in high-flow short vascular segments such as renal AVFs. Alternative embolization agents for high-flow AVFs are metallic coils, under flow control by a balloon to reduce the chances of coil migration, but these are less accurate and not as safe for high-flow targets.

Some would argue that an AVP 2 is superior to detachable coils because usually only one device is required and its deployment is really simple. However, the use of the AVP 2 has its limitations. In our case, the limitation is its size. For effective embolization, it is usually oversized by 50% of the size of the target vessel for more stability of the device and fewer chances of migration.[10,11] When the renal AVF is >15 mm in diameter, AVP 2 may not provide ideal embolization in calculations. The target AVF measured 11 to 26 mm in diameter (average, 15 mm), close to the upper limit of the ideal embolization using AVP 2.

We developed the new stent with wire-trapping technique for embolization of large, high-flow AVFs (Fig 5). This technique is based on establishment of a through-and-through wire for the safe and accurate deployment of a large bare stent, then cannulation with a microcatheter going through the meshes of the bare stent, leaving detachable coils in the path to construct an in-stent scaffold. The next step is deployment of detachable coils in the stent to entangle with the aforementioned coils. The final step is deployment of detachable coils to fill the gap between the stent and AVF through pre-embedded out-stent microcatheters. With large bare stents deployed as filters and part of a scaffold, we can occlude larger target vessels beyond the limit of the AVP 2. With the in-stent scaffold acting as a barrier, we can construct effective wire trapping in the stent to overcome the high flow of AVFs, preventing coil migration and providing immediate occlusion. In addition, the coils used for the embolization of the gap between the stent and vessel wall are blocked by bare stents without migration. The effectiveness of embolization can be immediately evaluated during the procedure. The advantage of our method compared with the AVP 2 is its potential usefulness for larger AVFs that are unsuitable for AVP 2 and other embolization materials. The disadvantage of our technique is its complicated nature and the fact that it is more time-consuming than simple embolization using AVP 2.

CONCLUSIONS

In this case report, we described a patient with decreased cardiac ejection fraction caused by a large high-flow renal AVF who was treated endovascularly by a novel method with a self-expanding bare-metal stent and a coil-trapping technique without short-term postoperative complications. Good short-term results of fistula closure were confirmed, whereas long-term results still require evaluation. This novel method is potentially effective for embolization of large high-flow AVFs when the arteriovenous connection is so large that there is a risk of embolization of coils across the AV fistula.

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