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CASE REPORT

Endovascular Management of Renal Arteriovenous Fistula: Three Case Reports

JK Fung, HK Chin, WKW Leung, KYK Tang, CY Chu, WK Kan

Department of Radiology, Pamela Youde Nethersole Eastern Hospital, Hong Kong SAR, China

INTRODUCTION

Renal arteriovenous fistula (AVF) is a rare vascular anomaly classified as traumatic or non-traumatic. There are no guidelines for endovascular treatment. Some case reports involve coil deployment[1,2] but some require additional techniques such as vascular plugs, occlusive balloons, or stents[3,4] to minimise the risk of coil embolisation.

We report three cases of renal AVF endovascular treatment, including two idiopathic AVFs, and focus on treatment considerations and technical perspectives with reference to current reported practices.

CASE PRESENTATIONS

Case 1

A 68-year-old female presented with haematuria. Elective computed tomography (CT) urogram demonstrated an AVF in the left kidney at the mid to lower pole. It was supplied by a hypertrophied renal artery, drained by a dilated renal vein and via the engorged inferior vena cava into the enlarged right atrium (Figure 1a and c). There were two relatively sizeable saccular aneurysms connected by a short stenotic segment (Figure 1b). The case was discussed with the vascular team and deemed unsuitable for endovascular stenting.

Digital subtraction angiography (DSA) confirmed the AVF was supplied by the main trunk of the left renal artery. The most proximal aneurysm was the largest at 3.5 cm (Figure 2a). Two 6-Fr guiding sheaths (Flexor Ansel; Cook Medical, Bloomington [IN], US) were advanced to the left main renal artery via a femoral approach. A 0.035-inch balloon catheter (Mustang [10 × 20 mm]; Boston Scientific, Marlborough [MA], US) was then directed to the proximal left main renal artery to control arterial inflow. Detachable coils (standard Ruby coils; Penumbra Inc, Alameda [CA], US) of various sizes and lengths were deployed into the most proximal aneurysm using the scaffold technique via a dedicated microcatheter (Excelsior XT-27; Stryker, Kalamazoo [MI], US) [Figure 2b]. The feeding left renal artery was eventually packed with detachable coils (0.035-inch Interlock; Boston Scientific, Marlborough [MA], US). Follow-up magnetic resonance (MR) renal angiogram 6 months later revealed significantly reduced vascularity in the dilated vessels and aneurysms (Figure 2c).

Correspondence: Dr JK Fung, Department of Radiology, Pamela Youde Nethersole Eastern Hospital, Hong Kong SAR, China
Email: jamesfung@gmail.com

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Case 2

A 49-year-old female presented with gross haematuria and loss of consciousness. Haemoglobin level was 7.8 g/dL on admission. CT urogram demonstrated a right AVF centred at the interpolar region, with acute blood products dilating the right renal collecting system and the right ureter (Figure 3).

On DSA, the AVF was shown to be supplied by two branches from the anterior segmental renal artery (Figure

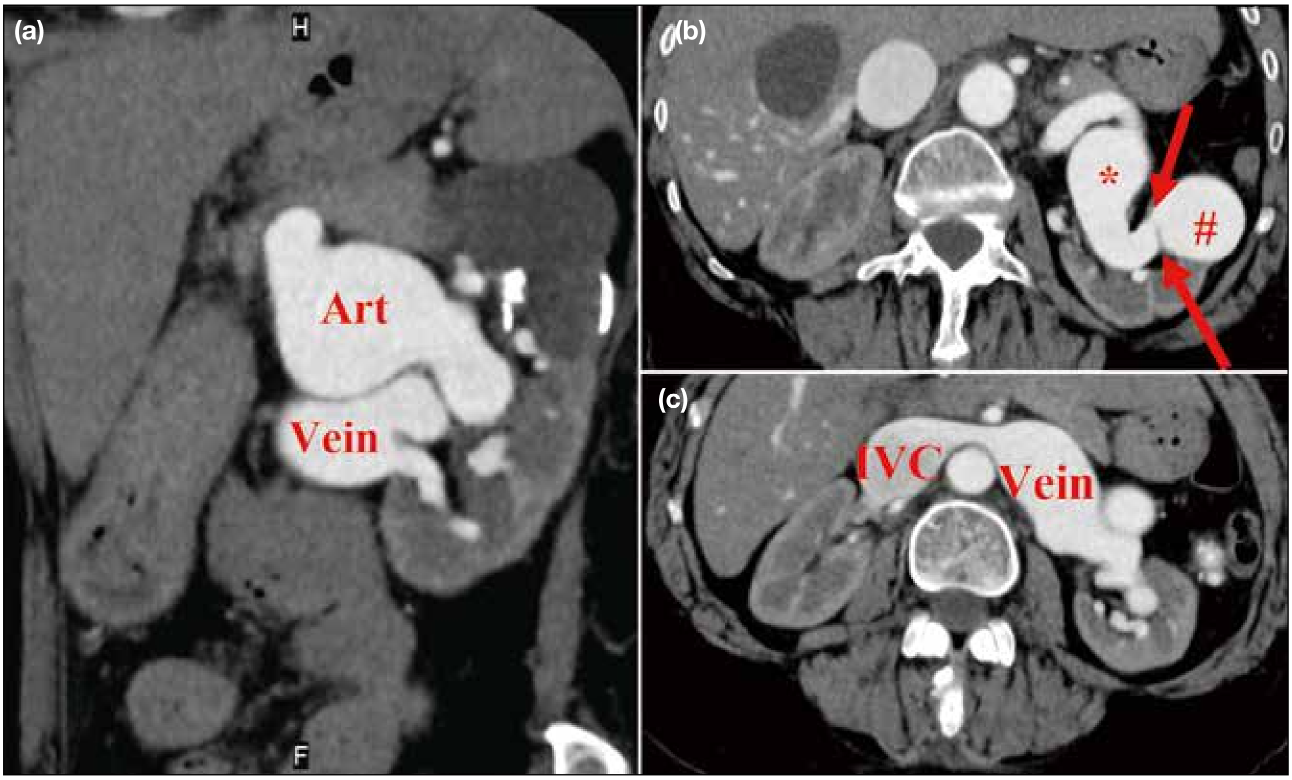

Figure 1. Case 1. Corticomedullary-phase contrast-enhanced computed tomography with maximal intensity projection in oblique sagittal (a) and axial (b, c) planes. (a) Hypertrophied supplying left renal artery (Art) and early opacification of the dilated draining renal vein (Vein). (b) Two saccular aneurysms (asterisk and hash) were connected by a stenotic segment (arrows). (c) Dilated draining renal vein (Vein) and inferior vena cava (IVC).

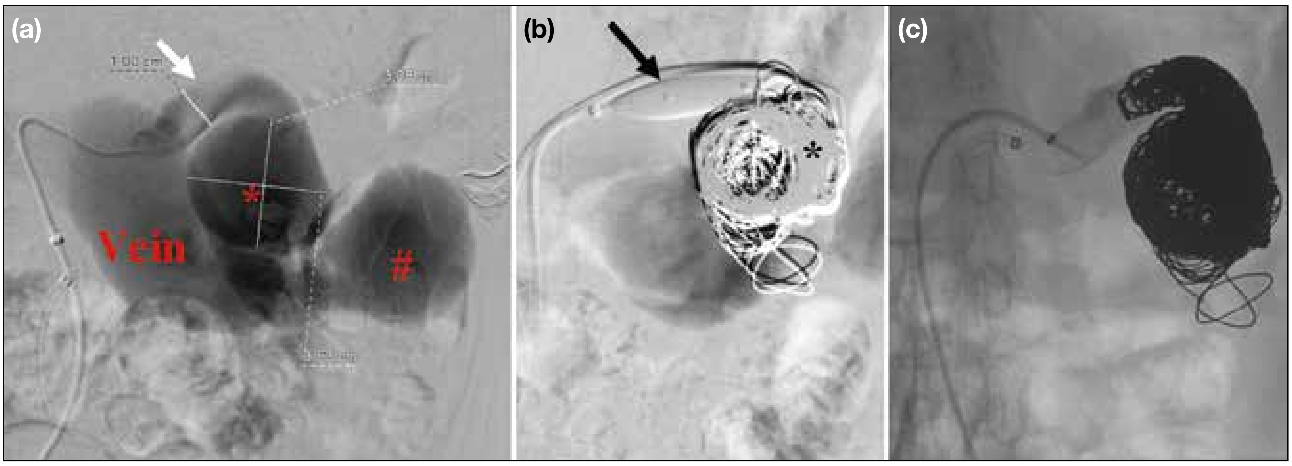

Figure 2. Case 1. Left renal digital subtraction angiography (DSA). (a) Pre-embolisation DSA shows the two aneurysms detected on computed tomography (asterisk and hash). The hypertrophied left renal artery (white arrow) measures 1 cm. (b) Application and packing with Ruby coils of various lengths into the more proximal aneurysm (asterisk). The stenotic segment allowed successful anchorage of the coils. The Mustang catheter balloon (black arrow) was inflated during coil deployment to reduce arterial inflow and prevent coil migration. (c) Check DSA confirmed significantly reduced vascularity across the arteriovenous fistula.

4a). Selective cannulation was achieved with a 2.7-Fr microcatheter (Rebar 18 reinforced microcatheter; Medtronic, Minneapolis [MN], US) [Figure 4c]. The first vessel supplying the right AVF was embolised with two detachable coils (Concerto Helix coils; Medtronic, Minneapolis [MN], US). A microvascular plug (MVP-3Q; Medtronic, Minneapolis [MN], US) was launched more proximally (Figure 4d) along the first artery to effectively address the smaller side branches (Figure 4b). The remaining artery was packed with detachable coils. The second artery supplying the AVF was first embolised with a detachable coil, followed by pushable coils (Nester microcoils; Cook Medical, Bloomington [IN], US) [Figure 4e]. Repeat DSA confirmed significant reduction in AVF vascularity [Figure 4f]. There was no recurrence of haematuria at 1-year clinical follow-up.

Case 3

A 48-year-old man was diagnosed with end-stage renal failure and managed by haemodialysis. A left renal AVF shown as a cystic area with moderate vascularity (Figure 5a and b) was incidentally detected on ultrasound and was presumed biopsy-related. Intervention was deemed indicated by nephrologists and urologists in view of the higher bleeding risk in end-stage renal failure. CT urogram confirmed an AVF centred at the lower pole of the left kidney with aneurysmal changes. Double renal arteries were seen. One of the renal arteries directly supplied the AVF and showed ostial stenosis and hypertrophy (7 mm) [Figure 5c]. The ostium measured 2.5 mm, limiting the option of sheaths and catheters. A short segment tight stenosis was seen in the dilated draining renal vein proximally near the renal hilum (Figure 5d), which minimised the migration of embolic agents.

The supplying renal artery was cannulated with a 5-Fr H1 catheter (Torcon NB Advantage Catheter; Cook Medical, Bloomington [IN], US) [Figure 6a]. The most proximal venous pouch was selectively cannulated (Excelsior XT-27). Using the scaffold technique, the venous pouch was packed with coils of varying lengths and calibres (Ruby coils) [Figure 6c]. A microvascular plug (MVP-7Q; Medtronic, Minneapolis [MN], US) was launched at the supplying left renal artery [Figure 6d], followed by more proximal deployment of two detachable coils [Figure 6e]. Check DSA confirmed significant reduction in AVF vascularity and absence of collateral supply from the other renal artery (Figure 6f).

DISCUSSION

To preserve renal function, endovascular treatment has become the mainstay treatment of renal AVF in the current literature. For non-traumatic AV shunts, Marunos et al[5] proposed corresponding treatment modalities based on three types of angioarchitecture. Type I involves single or few arteries shunting to a dilated single draining vein, while type II contains multiple arterioles shunting to a single dilated draining vein. Coils are recommended in these two types, while vascular plugs can be considered in type I shunts. For type III, where multiple connections exist between arterioles and venules, particles and liquid embolic agents are recommended. Proximal embolisation of the arterial feeder with coils in type III shunts should be avoided to prevent recruitment of collaterals. Traumatic

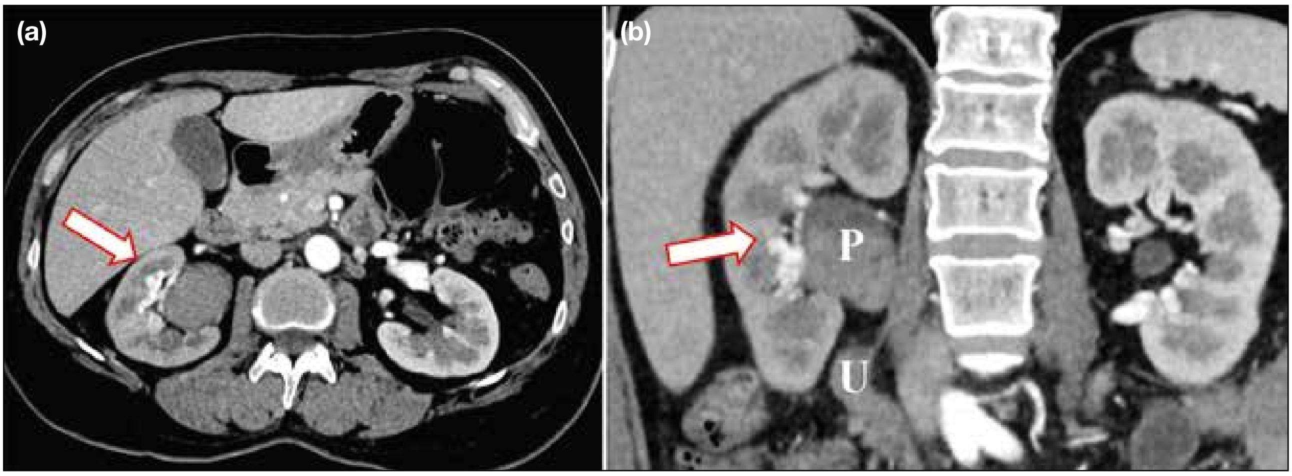

Figure 3. Case 2. Corticomedullary-phase contrast-enhanced computed tomography with maximal intensity projection in axial (a) and coronal (b) planes. Delayed nephrogram in both projections. Tortuous vascular structures with hyperenhancement are seen at the anterior interpolar region of the right kidney (arrows). The renal pelvis (P) and the right ureter (U) were dilated by hyperdense blood products. The right renal vein and inferior vena cava were not dilated (not shown).

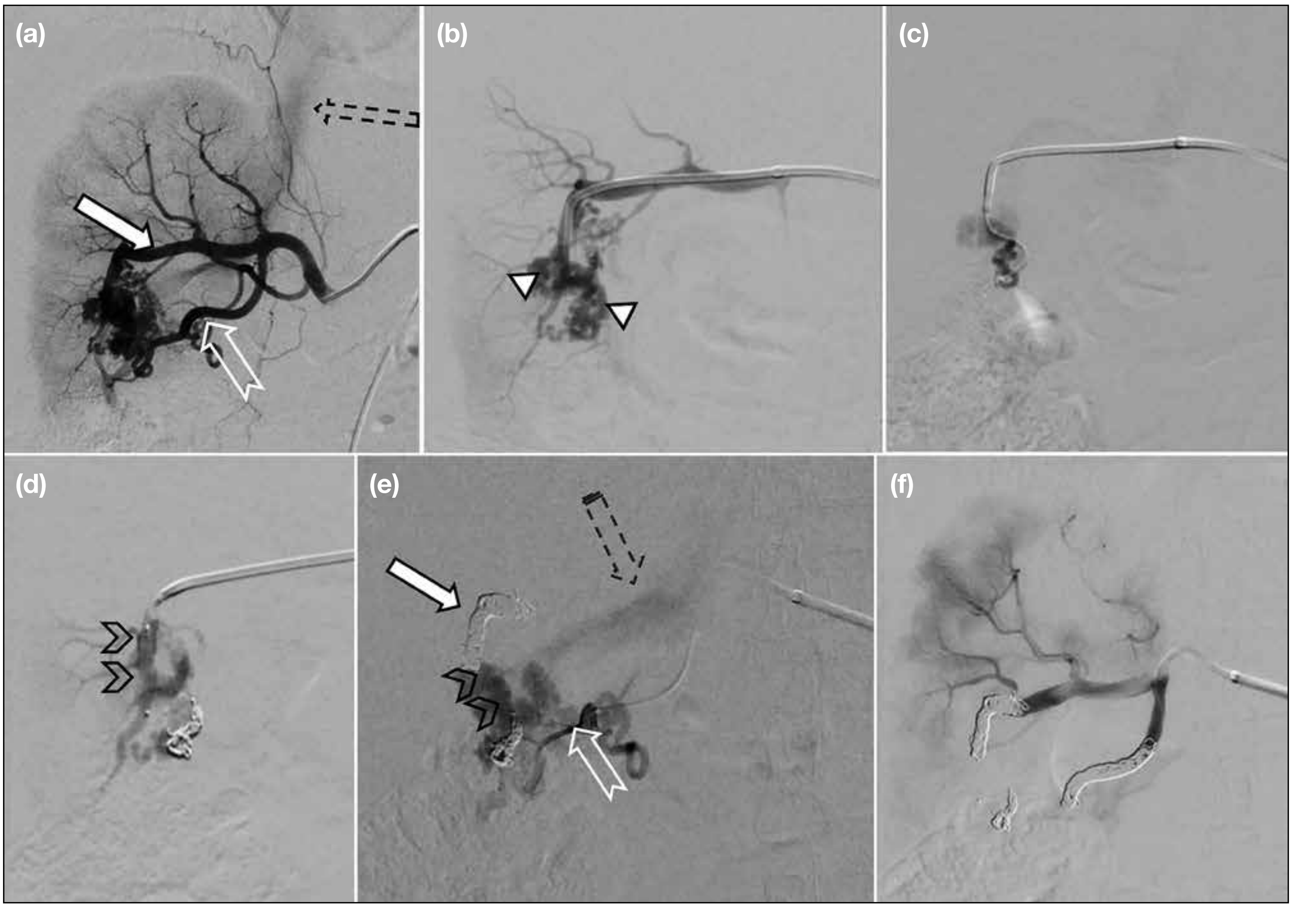

Figure 4. Case 2. Digital subtraction angiography (DSA) of right renal arteriovenous fistula. (a) Preprocedural DSA at the right main renal artery with an SHK catheter (Cordis, Miami [FL], US) confirmed supply by two branches of the anterior segmental renal artery (artery 1: white solid arrow, artery 2: hollow notched arrow). Early opacification of the inferior vena cava is noted (dashed arrow). (b) Selective cannulation showing small branches (arrowheads) supplied by artery 1. (c) Superselective angiogram with a Rebar 18 microcatheter confirmed dominant supply from one of the medial branches. (d) Deployment of an MVP-3Q microvascular plug (hollow arrowheads) proximally after distal coil embolisation. (e) Selective angiogram of artery 2 (hollow arrow) with a Rebar 18 microcatheter. Early opacification of the right renal vein is noted (dashed arrow). Note that the 4-6 mm larger coils (white solid arrow) had densely packed the proximal portion of artery 1. The MVP-3Q microvascular plug (hollow arrowheads) was located between the coils in artery 1. (f) Check DSA after coil embolisation of artery 2. Only tiny slow-flow serpiginous vessels were observed (not shown).

shunts, which usually present with pseudoaneurysms, are located peripherally and have similar angioarchitecture to type I shunts. As well as coils, glue is a treatment option. These endovascular treatment modalities are considered effective and are commonly used in clinical practice.

Detachable coils allow precise deployment and have low risk of non-target embolisation in a high-flow setting. Particles and liquid embolic agents are time-efficient in type III profiles but carry risks of proximal and non-target embolisation. The combination of distal coil anchor and proximal vascular plug is gaining in popularity, with reported success in recanalised[6] and giant AVF,[2] although limited case numbers mean its superiority has not been validated. Plugging is an efficient alternative to coil mass, but a straight non-conical landing zone is required. The maximum sizes that the Amplatzer or the MVP Micro Vascular Plug system offer may also limit their application in enlarged feeders. For Amplatzer vascular plugs, serial deployment may be considered to achieve optimal flow control, especially for larger plugs due to their larger pore size.[7] In our experience, deployment of a single plug may be insufficient for flow control. It is therefore our preference to perform distal coil packing.

AVFs impose an elevated risk of distal non-target embolisation due to their high-flow nature. To provide coil stability, the double-catheter technique (Case 1) or the side-branch anchor technique (Case 3) can be performed. Flow modulation with occlusive balloons applied proximal (Case 1) and distal to the fistula also provides stability for the initial coil framework.[8,9]

Figure 5. Case 3. Doppler ultrasound (a, b) and reformatted maximal intensity projection contrast-enhanced computed tomography in corticomedullary phase (c, d). (a) The arteriovenous fistula (AVF) presenting with cystic sacs with chaotic colour flow signal. (b) The supplying renal artery is hypertrophied, with a reduced resistive index of 0.34 (normal = 0.5-0.7). (c) Ostial stenosis (solid arrow) of the supplying renal artery, which narrows to 2.5 mm. (d) Short segment stenosis (hollow arrow) of the draining renal vein near the AVF.

The 'pre-framing' technique, which involves coiling the microcatheter in the designated area prior to coil deployment, has also been practised.[10] The rigidity of mechanically detachable or larger-sized coils is nonetheless technically difficult since the coils traverse through the tortuous catheter framework. It also risks catheter knotting and requires a side branch for the microcatheter to anchor upon. Alternatively, the use of covered or constrained stents for coil trapping has been successful.[3]

CT or MR arteriography provides an excellent roadmap for preprocedural planning and a crude estimation of the post-embolisation residual functional kidney. In Case 3 for example, ostial stenosis limited catheter sizing and subsequent choice of embolic agents. The venous outflow should also be carefully studied. A grossly dilated vein, as in Case 1, implies a high risk of distal non-target embolisation. A venous occlusive balloon is most reported to prevent distal embolisation. Suprarenal inferior vena cava filters may also be considered but their application is limited in flow-induced mega cava, as in Case 1. The use of an atrial septal defect occluder has also been reported.[11] Embolisation of the venous outflow tract is not commonly practised and not necessarily indicated when feeder obliteration is achieved. It may be considered when multifocal feeders are present, where extensive embolisation would result in lowered nephron-sparing capacity.

CONCLUSION

This case series is based on single-centre experience with a small sample size. Some cases were excluded, including those with difficult vascular anatomy and concerns about compromising renal function.

Endovascular treatment of three selected cases of renal AVF is illustrated. Various treatment modalities have been proven successful and may be selected according to the angioarchitecture. The combination of coil and plug is gaining popularity. The high-flow nature of AVF requires careful preprocedural planning and additional

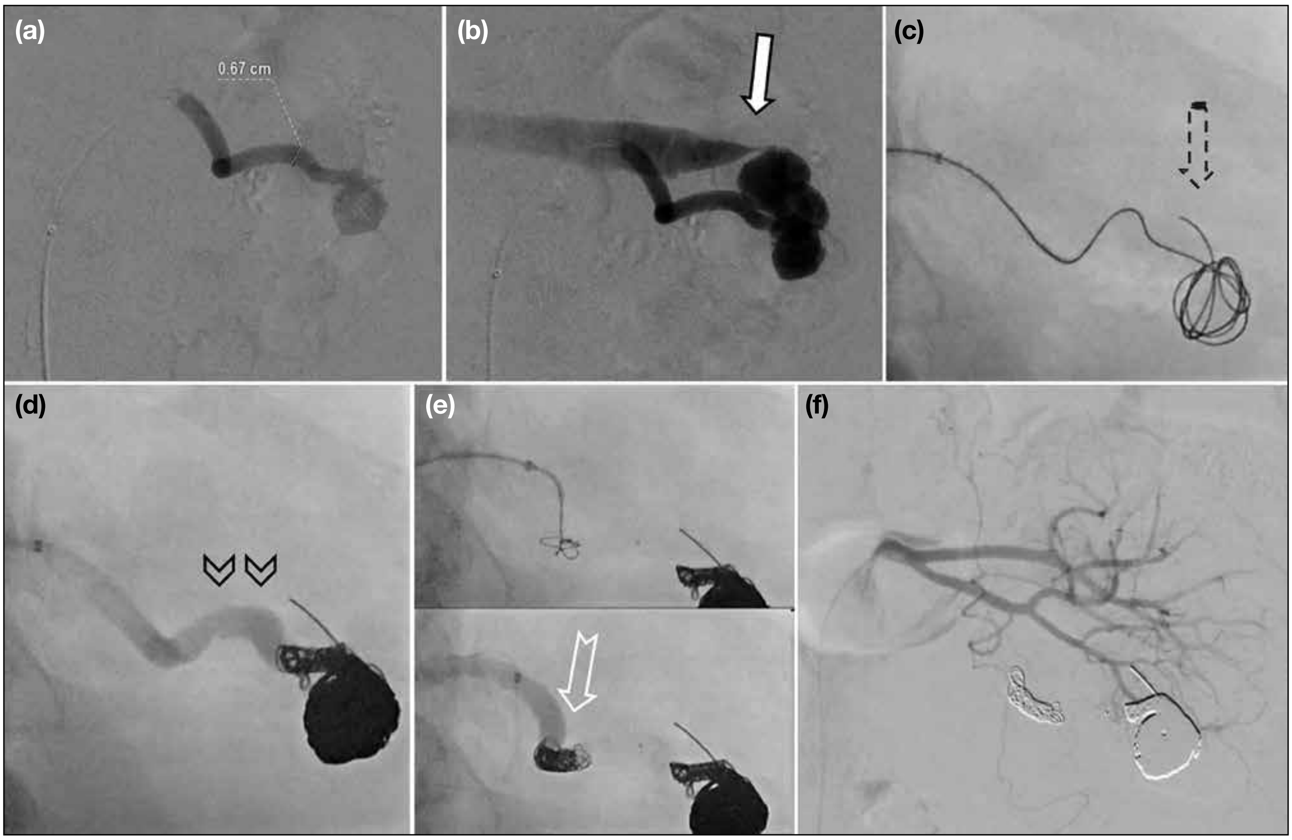

Figure 6. Case 3. Digital subtraction angiography (DSA) of left renal arteriovenous fistula. (a) Early-phase diagnostic DSA of the supplying renal artery (0.7 cm) with a H1 catheter. The most proximal venous pouch in the arteriovenous malformation (AVM) is opacified. (b) DSA confirms tight stenosis (solid arrow) at the distal left renal vein near the AVF. (c) Threading of Ruby coils, starting with larger coils with greater radial force. The anchor technique (dashed arrow), where the distal end was landed in a small adjacent branch, was applied to provide stability. (d) Deployment of an MVP-7Q microvascular plug (hollow arrowheads) proximal to the coil mass. Note the reflux of injected contrast along the renal artery. (e) Further proximal coil packing (hollow arrow) along the hypertrophied supplying renal artery with a Rebar 18 microcatheter (upper image). Reflux of injected contrast is again seen (lower image). (f) Check DSA of the other renal artery excluded collateral supply to the AVM.

intra-procedural manoeuvres to minimise the risk of embolic agent migration. Target coiling of larger aneurysms also contributes to treatment success.

REFERENCES

1. Nagpal P, Bathla G, Saboo SS, Khandelwal A, Goyal A, Rybicki FJ, et al. Giant idiopathic renal arteriovenous fistula managed by coils and Amplatzer device: case report and literature review. World J Clin Cases. 2016;4:364-8.
2. Yoneda S, Madono K, Tanigawa G, Fujita K, Yazawa K, Hosomi M, et al. Case of giant renal arteriovenous fistula in a long-term hemodialysis patient [in Japanese]. Hinyokika Kiyo. 2009;55:559-62.
3. Resnick S, Chiang A. Transcatheter embolization of a high-flow renal arteriovenous fistula with use of a constrained wallstent to prevent coil migration. J Vasc Interv Radiol. 2006;17:363-7.
4. Shie RF, Su TW, Hsu MY, Chu SY, Ko PJ. Transarterial embolization of a large high-flow right renal arteriovenous fistula using stents and an across-stent wire-trapping technique. J Vasc Surg Cases Innov Tech. 2019;5:122-7.
5. Maruno M, Kiyosue H, Tanoue S, Hongo N, Matsumoto S, Mori H, et al. Renal arteriovenous shunts: clinical features, imaging appearance, and transcatheter embolization based on angioarchitecture. Radiographics. 2016;36:580-95.
6. Abdel-Aal AK, Elsabbagh A, Soliman H, Hamed M, Underwood E, Saddekni S. Percutaneous embolization of a postnephrectomy arteriovenous fistula with intervening pseudoaneurysm using the Amplatzer Vascular Plug 2. Vasc Endovascular Surg. 2014;48:516-21.
7. Balasubramanian K, Keshava SN, Lenin A, Mukha R. Endovascular management of a patient with massive renal arteriovenous fistula: challenges and tricks. BMJ Case Rep. 2021;14:e236358.
8. Idowu O, Barodawala F, Nemeth A, Trerotola SO. Dual use of an Amplatzer device in the transcatheter embolization of a large high-flow renal arteriovenous fistula. J Vasc Interv Radiol. 2007;18:671-6.
9. Mansueto G, D'Onofrio M, Minniti S, Ferrara RM, Procacci C. Therapeutic embolization of idiopathic renal arteriovenous fistula using the "stop-flow" technique. J Endovasc Ther. 2001;8:210-5.
10. Sundarakumar DK, Kroma GM, Smith CM, Lopera JE, Suri R. Embolization of a large high-flow renal arteriovenous fistula using 035" and 018" detachable coils. Indian J Radiol Imaging. 2013;23:151-4.
11. Chen X, Zeng Q, Ye P, Miao H, Chen Y. Embolization of high-output idiopathic renal arteriovenous fistula primarily using an atrial septal defect occluder via venous access: a case report. BMC Nephrol. 2019;20:15.