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Trans-Arterial Embolization of High-Flow Renal Arteriovenous Fistula (AVF) with Concomitant Renal Artery Aneurysm

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Abstract

Arteriovenous fistula (AVF) is an abnormal direct communication between an artery and the venous drainage without a capillary component. Although renal AVF is rare, detecting the disease is important to assist in management and, thus, help reverse the sequelae of the disease such as hypertension and heart failure. The clinical presentation and radiological features are important parameters that can help in the diagnosis and decision of treatment. We would like to share our successful approach to a 52-year-old female with idiopathic high-flow left renal AVF with concomitant renal artery aneurysm using a single Amplatzer vascular plug in the limit of our setting.

Keywords
- renal AVF
- renal artery aneurysm
- Amplatzer vascular plug

Introduction

Renal arteriovenous fistula (AVF) is a rare disease and if associated with RAA is even more rare.[1] The presentation may not be specific ranging from flank pain, hematuria, hypertension, to the manifestation of high-output heart failure. Once detected, endovascular intervention is usually preferred over nephrectomy in the current practice and it may reverse the patients' initial symptoms due to the renal AVF. To our knowledge, there are less than 10 cases of renal AVF with concomitant RAA reported since 2015 and these cases were each treated using different approaches of endovascular embolic materials.

Case Report

We present a case of a 52-year-old female, with no known medical illness, previous surgical history, or previous history of trauma. She experienced on and off left flank pain for few months. She did not have hematuria, fever, or heart failure symptoms. Ultrasound revealed left staghorn calculus. Computed tomography multiphase renal (►**Fig. 1A, B**) showed an incidental finding of left renal AVF with concomitant aneurysm of the single feeding renal artery. The renal AVF received feeding artery from the lower pole segmental artery and had direct communication with left renal vein. There was a normal polar artery which supplied blood to the lower pole of kidney. Due to the staghorn calculus and incidental finding of left renal AVF, she was referred to our department for embolization.

Embolization was done under general anesthesia. Using the modified Seldinger technique, transcutaneous right common femoral artery puncture was done, followed by catheterization using an 8Fr arterial sheath. Aortography was done using a 5Fr pigtail catheter (Terumo Europe, Leuven,

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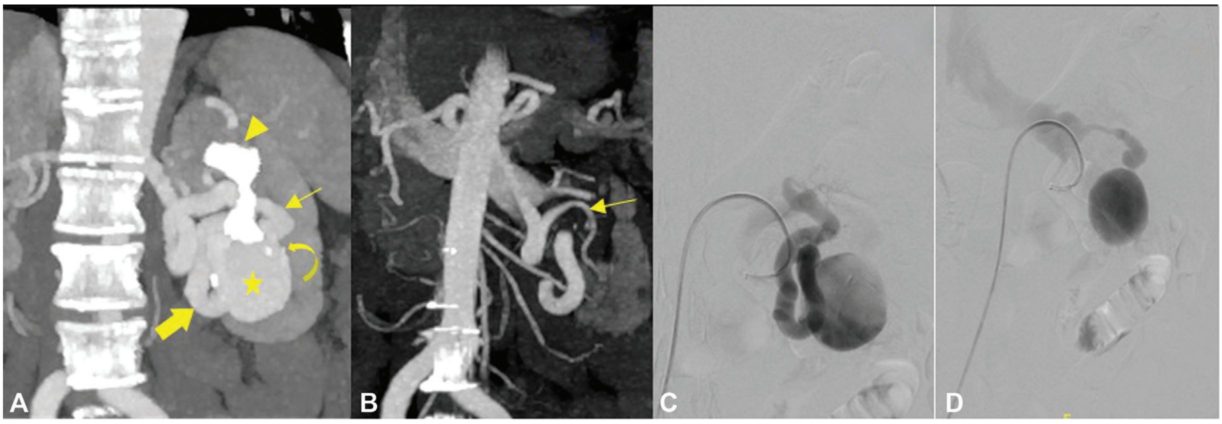

Fig. 1 MIP images of CT multiphase renal in the arterial phase. (**A**) The detail of left renal AVF was annotated in the picture. There is single tortuous feeding artery (*thick arrow*) and a draining vein (*thin arrow*). Please note the presence of RAA (*star*) before the fistulous site (*curved arrow*) and staghorn calculus (*arrowhead*). (**B**) Small normal segmental renal artery arise before the tortuous feeding artery which should be avoided during embolization (*arrow*). (**C**) Selective arteriogram image from the feeding artery showed RAA at the distal segment of feeding artery. (**D**) Selective arteriogram showed a narrower fistulous point after the RAA and it drains to single renal vein.

Belgium) which was introduced over a 150 cm hydrophilic guidewire (Terumo Europe, Leuven, Belgium). The aortography showed a left renal AVF with the presence of aneurysm measuring 3.8 cm at the pre-fistulous communication (►**Fig. 2A**). The lower pole segmental feeding artery selective cannulation was done using a 5Fr CB 1 catheter (Impress; Merit Medical system), and arteriogram done showed a high-flow AVF with single draining vein directly draining to the left renal vein. The feeding artery diameter was 7.5 mm. Considering that the pre-requisite for the suitable Amplatzer

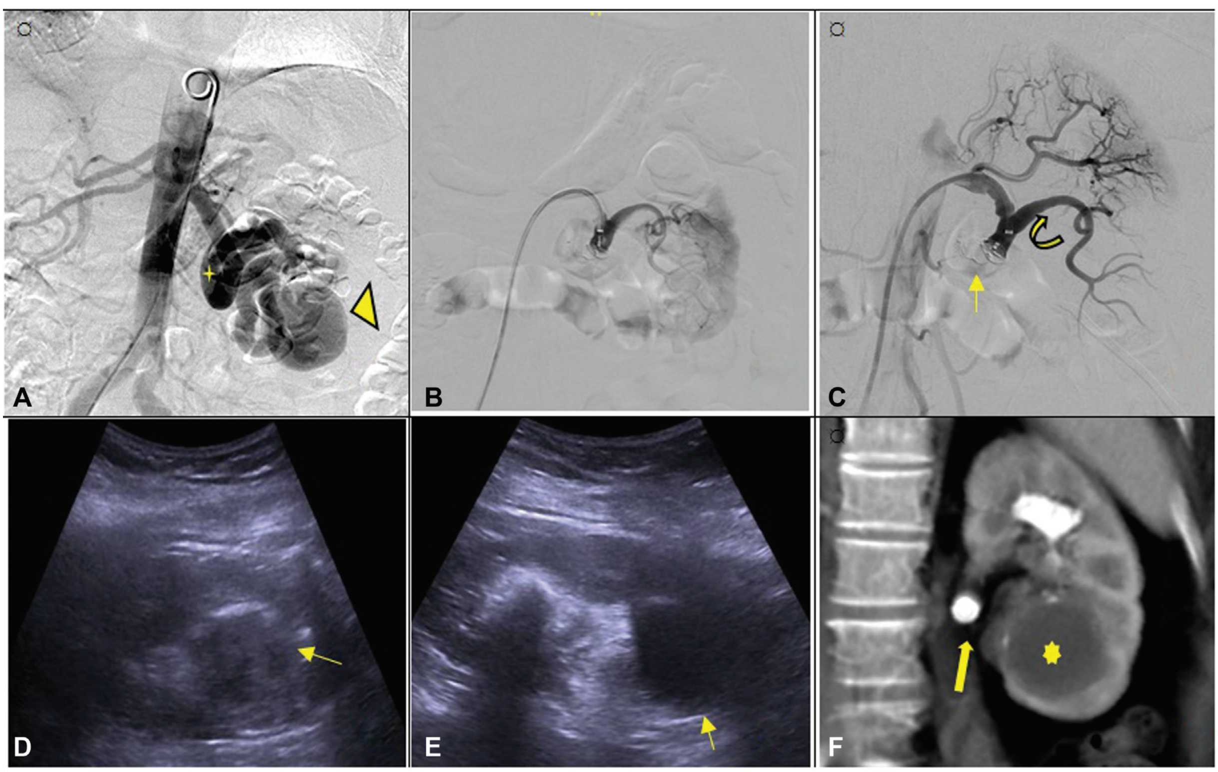

Fig. 2 (**A**) DSA image of aortogram showed a fast flow left renal AVF. The presence of large aneurysmal sac (*arrow head*) before the draining vein and the initial target site for an Amplatzer Vascular plug were observed. (**B**) Pre-detachment of Amplatzer vascular plug. Arteriogram was done through the 6Fr 45 cm long sheath which showed non-opacification of vessels distal to the vascular plug. (**C**) Post-embolization of the feeding artery. The selective arteriogram done through the 6Fr 45 cm long sheath after the detachment of the Amplatzer vascular plug. There was no opacification of the left renal AVF. Normal contrast flow was seen to the normal segmental renal arteries (*curved arrow*). The vascular Amplatzer plug was shown by arrow which was placed more proximal than the initial plan. (**D**) and (**E**) Ultrasound images at second week and fourth week, respectively, showed thrombosed aneurysm (*arrow*) at second week and anechoic aneurysm at fourth week. (**F**) MIP image of post-embolization CT follow-up in coronal plane showed the Amplatzer vascular plug in place (*arrow*) with non-opacification of the RAA (*star*) as well as non-visualization of the renal AVF.

vascular plug is 30 to 50% from the target artery size, a size 12 mm vascular plug was chosen. Later, a CB1 catheter was removed and exchanged with a 6Fr 45 cm long sheath (Flexor Check Flo Introducer Cook Meical, Europe). An Amplatzer vascular plug II of size 12 mm (Abott: Amplatzer vascular Plug II) then advanced within a 6Fr 45 cm long sheath (Flexor Check Flo Introducer Cook Meical, Europe) and the Amplatzer was opened and left in place for 7 minutes. A selective segmental renal angiogram was done through the 6Fr 45 cm long sheath (Flexor Check Flo Introducer Cook Meical Europe) which showed complete non-opacification of the renal AVF with better blood flow to the rest of segmental renal arteries and good renal enhancement (►**Fig. 2B**). The Amplatzer vascular plug was then detached by rotating the plug wire in anticlockwise direction. Post-detachment of the Almplatzer vascular plug, another checked angiogram was performed through the long sheath which showed Amplatzer was in place and complete non-opacification of the renal AVF.

Post-procedure, the patient was well, there was no abnormality in the renal function test, and the patient was discharged. During follow-up review 2 weeks and 4 weeks post-procedure, the patient was asymptomatic and did not experience hematuria. Ultrasound revealed no evidence of renal infarction shown in ►**Fig. 2D, E**.

A follow-up CT (►**Fig. 2F**) was done after 2 months which revealed that there was non-opacification of the left renal AVF with no revascularization. No migration of the Amplatzer vascular plug was observed. She was reviewed by the urology team and was planned for percutaneous nephrolithotripsy.

Discussion

It has been known that renal AVF is not common. Renal AVF is classified based on etiology into congenital (14–27%), acquired (70–80%), and idiopathic (3%).[2] The occurrence of renal AVF with concomitant renal artery aneurysm (RAA) is also rare, accounting for 2.8% of renal AVF.[3] Detection is mainly done by imaging as a routine examination for hypertension and heart failures as these diseases are also attributable to renal AVF. It is believed that AVF with concomitant RAA is due to the gradual erosion of an aneurysmal wall from the adjacent vein.[1] In our case, we were unable to determine the cause of renal AVF because patient did not undergo the interventional procedure before. However, the presence of the staghorn calculus could be the cause for the formation of RAA. Our patient's diagnosis was made as incidental findings from CT multiphase renal, and there was no associated disease such as hypertension or high-output heart failure. There are reported cases of renal AVF with concomitant renal vein aneurysm as well as cases of renal AVF with concomitant RRA, and the management of treatment in these cases are different depending on the nature of the fistula as well as the relationship of fistula with aneurysm.[1,2]

The aim of treatment is to relieve recurrent hematuria, circulatory overload, hypertension, and hemodynamic abnormalities.[4] It is also important to retain the functional nephron as much as possible. Although our patient's symptoms were not serious, there was a need for early treatment to prevent RAA rupture. Prior to the use of endovascular embolization, AVF, RAA, or combination of both was treated surgically with arterial reconstruction and partial or total nephrectomy.[1] However, with surgery there was a risk of renal parenchymal and functional loss. In the current practice, the majority of renal AVF are treated with endovascular embolization to preserve the function of nephron as well as renal function. The first endovascular embolization techniques were reported in 1970's where the autologous clot was used for embolization.[5] As time went by, multiple other types of embolic agent were available, for example, polyvinyl alcohol, gelfoam sponge, steel coil, cyanoacrylate, and, the most recent, the usage of vascular plug. Embolization should aim at the abnormal feeding artery while trying not to affect the normal renal artery; hence, we need to also consider which part of the feeding artery to occlude.[6]

In the treatment of our patient, we considered the different types of embolic agents, high-flow feature, and cost of treatment. We found the use of polyvinyl alcohol, gel foam sponge, and cyanoacrylate unsuitable as they are small and pose a risk of dislodge, which can lead to pulmonary embolism.[4] In addition, the cost of using multiple steel coils is high and would increase patient's cost of treatment, thus not a viable option. As such, a vascular Amplatzer plug was chosen because of its ability to self-expandable, higher density, higher flow disturbances effect, and cost-effectiveness. We used the Amplatzer vascular plug II (AVP II) because it is the only vascular plug available for use in Malaysia and also it is the most appropriate type for oversizing calculation. In this case, the placement of the Amplatzer vascular plug is planned at the specific level of the feeding artery as shown in ►**Fig. 2A**. However, the only available longest catheter to deliver the Amplatzer vascular plug at the time of procedure was a 45 cm long sheath (Cook Medical, Europe). The maximum length that the sheath tip can reach is at just distal to the origin of normal segmental renal artery shown in ►**Fig. 1B** hence resulted in the current more proximal placement.

Summary of renal AVF cases which is associated with RAA or renal vein aneurysm is given in ►**Table 1**. The approach to different cases is based on the anatomy of the renal AVF and its relation to aneurysm. In our case, the tortuosity of the feeding artery was one of the factors that contributed to the success of embolization with single Amplatzer which helped in holding the Amplatzer in place.

Conclusion

In conclusion, there are multiple causes and types of renal AVF. Once the renal AVF is detected, multiple considerations are needed before deciding on the best treatment option to the patient. In this case, we highlighted our limitations in terms of embolic material options and how we overcame the limitations. Despite the limitations, we successfully embolized the renal AVF with the single Amplatzer vascular plug.

Conflict of Interest
None declared.

Table 1 Summary of previous similar cases

No.	Authors	Radiological findings	Approach	Outcome
1	Trocciola et al (2005)[7]	Right renal artery aneurysm with concomitant AVF from the superior aspect of the aneurysm sac.	- Embolization with multiple coils.	Successful with no complication
2	Hongsakul et al (2017)[1]	Left upper polar artery juxta ostium aneurysm with continuation to feeding artery toward the AVF. The aneurysm is far from the renal AVF.	- Embolization of AVF with interlocking coil and glue.-Embolization of juxta ostium aneurysm with an Amplatzer vascular plug.	Successful with no complication
3	Rhee et al (2019)[2]	High-flow left renal AVF with multiple renal vein aneurysm.	- Embolization with two Amplatzer vascular plug. Malposition noted to the first plug hence a second plug is placed directly into the proximal part of renal artery.	Successful with subtotal infarction of the left kidney.
4	Tigkiropoulos et al. (2019)[8]	Combined RAA and AVF	Repair of distal RAA with AVF using stent graft.	Successful
5	Balasubramanian et al (2021)[9]	Large right renal AVF with aneurysmal dilatation of the venous end.	- First embolization with interlocked detachable coil, Amplatzer vascular plug. - Second embolization was done with two Amplatzer vascular plug and coils after noted on CT the Amplatzer used for first-time embolization was dislodged to the renal vein aneurysm.	Successful after second embolization.
6	Current case (2021)	Left renal AVF with concomitant renal AVF. Tortuous feeding artery for the renal AVF.	- Embolization with a single Amplatzer vascular plug.	Successful with no complication.

Abbreviations: AVF, arteriovenous fistula; CT, computed tomography; RAA, renal artery aneurysm.

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