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Case Report

Endovascular treatment of a wide-necked renal artery aneurysm with a flow diverter stent☆

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ABSTRACT

Renal artery aneurysm (RAA) is a rare, often asymptomatic disease (0.1% incidence in general population) and can be incidentally diagnosed during an abdominal imaging workup. The traditional, gold standard of treatment is open surgery, carrying with it, however, a high risk of nephrectomy, mortality, and collateral morbidity. The endovascular approach is currently the most valid alternative to treating RAAs reducing, as it does, the risks associated with the surgical approach/open surgery. Herein we report on our experience with a case of wide-necked RAA treated with the Pipeline Vantage (Medtronic) flow diverter stent. Wide-neck aneurysms are defined as having neck diameters greater than 4 mm. Our choice of endovascular treatment was preferred over the surgical option notwithstanding the large size of the neck and the involvement of the branching vessels.

Introduction

Renal artery aneurysms (RAAs) are relatively rare vascular pathologies occurring in the renal artery which supplies blood to the kidneys. Aneurysms are abnormal dilations or ballooning of a blood vessel caused by the weakening of the vessel wall. In contrast, pseudoaneurysms are typically caused by a tear in the vessel wall that is contained within the outermost layer of the artery (adventitia) or by a hematoma that forms around the damaged vessel [1]. RAAs being typically asymptomatic, they are often discovered incidentally during imaging studies for other conditions yet can also manifest in symptoms such as hypertension, abdominal pain, or even rupture. RAA incidence is estimated to be around 0.5%-1% in the general population. The most common cause of RAAs is atherosclerosis, but other causes such as fibromuscular dysplasia, trauma, and congenital defects

Abbreviations: RAA, Renal Artery Aneurysm; CT, Computerized Tomography.

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Fig. 1 – Coronal CT scan projection of RAA.

can also play a role. Management of RAAs typically involves either surgical or endovascular intervention, depending on their size, location, and the symptoms associated with the aneurysm.

Case report

A 66-year-old man was admitted to our hospital due to an incidental detection of a right RAA by a CT-scan performed for abdominal control after a suspected right RAA was detected by a previous ultrasound examination that had been performed for moderate flank pain. The patient had a clinical history of hypertension and no reported symptoms or laboratory evidence of renal impairment. The CT scan showed a saccular right RAA (maximum diameter 30 mm x 17 mm, neck diameter 14 mm) with 2 vascular branches, one on the antero-superior side and the other on the postero-inferior side. (Figs. 1 and 2). The RAA did not involve the renal pelvis nor ureter. Laboratory investigations included a complete blood count, renal and liver function tests, electrocardiography, chest radiography, ultrasonographic evaluation of the carotid artery, abdominal aorta, and the visceral arteries were carried out prior to the treatment and did not reveal any anomalies.

After a multidisciplinary consultation with vascular surgeons and interventional radiologists, the patient was admitted to our unit to perform an endovascular repair with an implant of a flow diverter stent and embolization of the aneurysmatic sac through a femoral approach under local anesthesia. Standard written informed consent was obtained prior to procedure.

Under local anesthesia, a 6 Fr vascular sheath was positioned in the patient's right common femoral artery and an intravenous bolus of 5000 IU of heparin was administered. A 5 Fr guide catheter (Merit Medical) was advanced on a standard guidewire (0.035′, Terumo) and selective catheterization of the right renal artery was performed. The subsequent angiographic control confirmed a large saccular aneurysm of the renal artery. (Fig. 4) A 6 × 30 mm Pipeline Vantage (Medtronic) flow diverter stent was deployed using a BMW 0.14 guide wire and a Phenom 27 microcatheter and the aneurysmatic sac was embolized with 5 coils (AXIUM coils: 1 of 16 × 400 mm, 12 × 300 mm, 7 × 300 mm and 2 of 14 × 300) (Fig. 5). The complete angiogram showed correct stent deployment, aneurysm exclusion and complete renal patency (Fig. 6). Finally, hemostasis was obtained with a percutaneous closure device (Angio-Seal 8F Terumo) and adequate compressive medication.

At the 1-month CT check the flow diverter stent appeared to be well positioned with exclusion of the aneurysmal sac. Arterial flow to the kidney was present, with the organ demonstrating good cortico-medullary differentiation.

No intraoperative and postoperative complications occurred and the patient was discharged after 2 days of hospitalization with a prescription of double antiplatelet therapy which included acetylsalicylic acid (100 mg daily) and clopidogrel (75 mg daily) for 6 months because of the anatomical tortuosity of treated artery and the use of stent and coils. After 6 months clopidogrel treatment was interrupted and only acetylsalicylic acid (100 mg daily) was maintained without complicances. A CT exam at 1 month showed good results (Fig. 3).

Creatinine values were and have remained stable and, upon publication, the patient is in excellent clinical condition. Before the procedure, the creatinine value was 0.89mg/dl, while after the procedure the creatinine value was 1.12 mg/dL.

Discussion

In 2020 the Society for Vascular Surgery (SVS) published the guidelines for visceral aneurysm management, whereby they cited an incidence of RAA of 0.1% in the overall worldwide

Fig. 2 – Volume rendering CT scan of RAA.

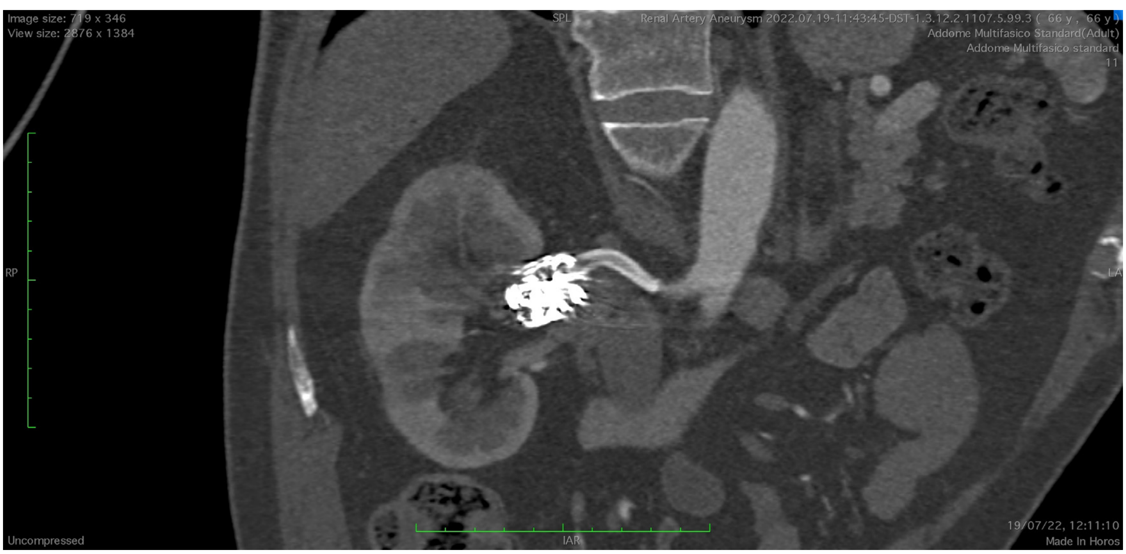

Fig. 3 – One month MPR reconstruction CT scan of RAA after endovascular procedure.

population [2]. RAAs are often recognized incidentally at imaging and, as in our case, are often asymptomatic, while once ruptured, abdominal pain and hemodynamic shock is the most common clinical presentation, even if mechanical compression of the parenchyma could cause in kidney decay, hematuria, pain and hypertension [3].

Morphological classification divides RAAs into saccular, fusiform, dissecting, and intrarenal. Alternately, Rundback classified them according to the arterial segment involved: Type I being a saccular aneurysm of the main renal artery or of a large segment branch, Type II a fusiform aneurysm of renal artery bifurcation and type III an interlobar artery aneurysm [3].

RAA genesis is atherosclerotic and related to media degeneration as other visceral aneurysms but they can also be caused by connective tissue diseases such as fibro-muscular dysplasia, Marfan syndrome, and Ehlers-Danlos syndrome [4].

The gold standard for imaging of RAAs is a contrast enhanced CT, preferably in 1 mm sections, while a magnetic resonance imaging is mandatory in cases of pregnant woman and patients with contrast allergy. A catheter-based angiography is more sensitive in recognizing/distinguishing distal microaneurysms, but its role is more operative, rather than diagnostic, during the endovascular approach [2,4].

Ultrasound plays a crucial role in the diagnosis of both pseudoaneurysms and aneurysms. For pseudoaneurysms, Doppler ultrasound can detect a hypoechoic "cystic-like" structure adjacent to the artery and a blood flow pattern with a characteristic "yin-yang" appearance. However, it may have limited sensitivity in evaluating deep arteries or in patients

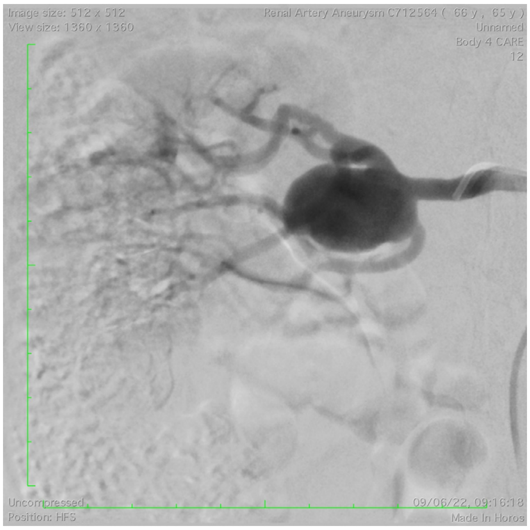

Fig. 4 – Right renal artery aneurysm selective angiography.

Fig. 5 – Right renal artery selective angiography with flow diverter stent positioning and coils implant.

with trauma or hematomas. On the other hand, aneurysms on ultrasound appear as localized, rounded dilations of the blood vessel wall, typically with a sacculated or fusiform shape. The imaging can also show a thickened aneurysmal wall and turbulent flow within the aneurysm. Ultrasound can be used to monitor the size of the aneurysm over time and assess any changes in blood flow in the affected area [5].

Published literature reports a low growth rate of RAAs ranging from 0.06 to 0.86 mm/y and, consequently, SVS guidelines indicate surgical repair in cases of symptomatic RAAs with an aneurysm diameter of >3 cm, in all women of childbearing age, and in patients with refractory hypertension and renal artery stenosis [2,6–10].

Open surgery is considered the primary/first choice of treatment, with success rates of 93%-100% in terms of freedom from occlusion and survival rates of 90% at 10 years. Although some reported cases a have shown a higher risk of

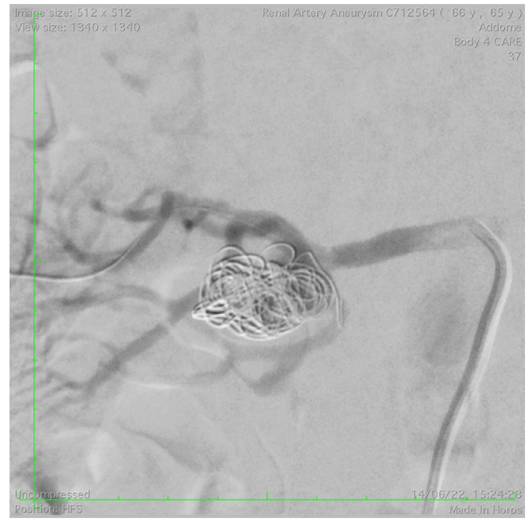

Fig. 6 – X-Ray images show the correct position of the flow diverter stent and the coils without endovascular protrusion inside the artery.

death within thirty days due to complications such as intraoperative and postoperative bleeding, there is no evidence in the literature of significant differences in short-term and long-term mortality rates with an endovascular approach [2,11–14].

Exclusion of RAA through stents and embolization is characterized by success rates of 73%-100% and variable complication rates of 13%-60%. As well, embolization with coils, onyx or plugs can be used to reduce risk of bleeding as a prior step to open surgery or as a useful combined 1 step therapeutic strategy [15–22].

Endovascular repair with isolated covered stents or in combination with embolic devices is successful in cases of simple RAA, while complex aneurysms are more challenging, especially when the dilatation involves the bifurcation of the main renal artery or major arterial branches. In such cases a valid endovascular alternative would be an implant of a flow diverter stent with an immediate reduction in mean velocity and vorticity within it, and without complete occlusion of branches and collaterals emerging from the aneurysm. As well, flow diverter stent are more efficient in cases of small tortuous arteries such as those in cerebral and coronary circulation [23–27].

Reported in the literature by Semeraro et al. [27], the use of FDS for treatment of wide-neck aneurysms (>4 mm) and\or those that present difficulties with a surgical approach, is being increasingly adopted. The use of FDS promotes the reconstruction of the parent vessel by slowing the blood flow in the aneurysm and causing an inflammatory response, followed by thrombosis and gradual exclusion of the aneurysm. The stent acts as a scaffold for the neointimal proliferation and remodeling of the parent vessel. Although the flow-modulation mechanism leads to earlier sac depressurization, the time required to achieve aneurysm exclusion is longer in terms of weeks to months when compared to conventional techniques. However, rather than thrombosis, the most predictive effect/measurement of clinical success is a dimensional reduction of the sac resulting from aneurysm depressurization.

As previously highlighted by Rabuffi et al. [28], use of FDS in treatment of wide-necked visceral aneurysms achieved a dimensional reduction rate of 55.8%, and only 1 of 6 patients treated with FDS had asymptomatic renal hypoperfusion at 12 months.

Our case of a 66-year-old man involved a highly intricate, wide-necked RAA encompassing multiple branching vessels. The complexity of the patient's procedure arose from the fact that the RAA affected a large area which presented a significant challenge both in terms of surgical treatment and the endovascular techniques employed.

The surgical approach was limited due to the location of the aneurysm and the surrounding vessels, while a conventional endovascular approach was difficult due to the aneurysm's wide neck and multiple side branches arising directly from it. As a result, we deemed using FDS in the treatment of RAA as a viable option in light of the surgical difficulties presented.

The new flow diverter stent PIPELINE VANTAGE (Medtronic) was selected due to its advanced technical features and encouraging literature reports, as it is equipped with Shield Technology, which can achieve a proven reduction in implant material thrombogenicity by covalently bonding phosphorylcholine to the surface of the implant with a reduction of thromboembolic risk within the stent and a better flow diversion for excluding the aneurysmatic sac [29–32].

The flow diverter stent redirects the blood flow away from the aneurysm which can help to decrease the risk of rupture and enhance patient outcome.

The intraoperative procedure was facilitated by the FDS' advanced re-sheathing mechanism and its single core wire, while also reducing friction and improving navigability, facilitating pushability, advancement and stability. We found results at intraoperative control satisfactory and technical success was confirmed at the postoperative control at the ensuing 30 days.

In order to ensure optimal results and reduce risk of complications, we decided to use FDS in combination with embolic coils. The coils provide an immediate reduction of flow into the aneurysm, while the FD promotes long term thrombosis and aneurysm exclusion. We found that this combination provided us with a higher degree of certainty that the aneurysm would be excluded leading us to assume that the use of FDS in combination with embolic coils is a good/an effective strategy for the treatment of aneurysm in abdominal vessels.

Despite the off-label status of FDS for visceral vessels, their unique hemodynamic properties and the increasingly reported favorable outcomes make them a valuable tool in the armamentarium of surgeons. Further studies on a larger series of patients are necessary to gain a better understanding of the optimal use of FDS in treating visceral aneurysms, but we feel confident in asserting that their combination with coils remains a safe and effective option for treating these challenging lesions.

Conclusion

In cases of RAA an endovascular approach is preferred when open surgery is contraindicated due to a patient's clinical or anatomical conditions or a refusal to undergo surgical procedure. The endovascular technique is a standard practice and proves similar results in the periprocedural and postoperative follow-up. In our wide-necked RAA patient, our choice of a flow diverter stent proved to be a valid alternative to covered stents or embolic exclusion or to the open surgical technique. Furthermore, its use as described in the literature shows encouraging results for a significant and respective therapeutic strategy in the treatment of wide-necked aneurysms. Based upon our experience as described herein, PIPELINE VANTAGE (Medtronic) is an effective device for treating RAAs and we look forward to future reports concurring with our positive experience.

Patient consent

A valid and written informed consent for publication of our case report was obtained from the patient correctly.

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