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Case Report

Transcatheter Amplatzer vascular plug-embolization of a giant postnephrectomy arteriovenous fistula combined with an aneurysm of the renal pedicle by through-and-through, arteriovenous access

Transfistulär-durchgezogener, arteriovenöser Führungsdraht und transvenöse Freisetzung eines Amplatzer vascular plug zur Embolisierung einer großen arteriovenösen Fistel nach Nephrektomie

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Abstract

Although endovascular transcatheter embolization of arteriovenous fistulas is minimally invasive, the torrential flow prevailing within a fistula implies the risk of migration of the deployed embolization devices into the downstream venous and pulmonary circulation. We present the endovascular treatment of a giant postnephrectomy arteriovenous fistula between the right renal pedicle and the residual renal vein in a 63-year-old man.

The purpose of this case report is to demonstrate that the Amplatzer vascular plug (AVP) can be safely positioned to embolize even relatively large arteriovenous fistulas (AVFs). Secondly, we illustrate that this occluder can even be introduced to the fistula via a transvenous catheter in cases where it is initially not possible to advance the deployment-catheter through a tortuous feeder artery. Migration of the vascular plug was ruled out at follow-up 4 months subsequently to the intervention.

Thus, the Amplatzer vascular plug and the arteriovenous through-and-through guide wire access with subsequent transvenous deployment should be considered in similar cases.

Keywords: arteriovenous fistula, AV-fistula, nephrectomy, embolisation, endovascular treatment, arteriovenous access, through-and-through, transvenous access, Amplatzer vascular plug

Zusammenfassung

Obwohl die endovaskuläre Katheter-Embolisation von arteriovenösen Fisteln minimal-invasiv ist, impliziert die, in der Fistel vorherrschende, hohe Strömungsgeschwindigkeit ein Risiko zur Migration des Embolisats in den nachgeschalteten venösen Abstrom und in den Lungenkreislauf. Wir beschreiben die endovaskuläre Behandlung einer großen arteriovenösen Fistel zwischen der rechten Nierenarterie und residueller Nierenvene nach Nephrektomie im Fall eines 63-jährigen Mannes.

Dieser Fallbericht demonstriert, dass der Amplatzer vascular plug sicher innerhalb sogar relativ großkalibriger AVFs platziert werden kann. Zweitens zeigen wir, dass dieser „Occluder“ sogar über einen transvenösen Katheter in die Fistel eingebracht werden kann, falls es initial nicht möglich ist, den Freisetzungs-Katheter über die (in unserem Fall) stark gewundene zuführende Arterie in die Fistel einzuführen. Migration des „vascular plug“ wurde in der Verlaufskontrolle 4 Monate postinterventionell ausgeschlossen.

Der hier vorgestellte kombiniert-arteriovenöse Zugangsweg mittels transfistulär durchgezogenem Führungsdraht und nachfolgender, transvenöser Freisetzung des Amplatzer vascular plugs sollte in ähnlichen Fällen berücksichtigt werden.

Schlüsselwörter: arteriovenöse Fistel, AV-Fistel, Nephrektomie, Embolisation, endovaskuläre Therapie, arteriovenöser Zugang, transvenöser Zugang, Amplatzer vascular plug

Introduction

Giant AVFs subsequent to nephrectomy are located extraparenchymal and are relatively rare whereas acquired, iatrogenic renal AV fistulas subsequent to percutaneous renal procedures, such as biopsy or minimally invasive partial nephrectomy, are a well-described, much more common complication [1].

Reviews found in the world literature have included 62 cases of postnephrectomy arteriovenous fistulas (AVFs) in 1985 [2], [3]. A search for case reports on NCBI Pubmed for the time-period from 1986 until 2012 containing the words “postnephrectomy arteriovenous fistula” or “nephrectomy arteriovenous fistula” in their title results in another 30 case reports.

Interestingly, 75% of postnephrectomy AVFs are observed on the right [4]. Congenital and idiopathic AVFs constitute less than 30% of all renal AVFs [5].

As in the present case, an aneurysm of the renal pedicle is sometimes associated with the AVF [6], [7], [8], but is not a sine qua non condition.

According to similar case reports, patients concerned often present with flank pain, easy fatigability with exercise, and dyspnea due to a high shunt-volume [8].

Early discovery is usually dependent on the caliber of the fistula. Giant AVFs can be responsible for increased cardiac output / cardiac index and decreased periphereal resistance which leads to diastolic overload and finally to heart failure [9]. At the time of diagnosis, 90% of patients have a bruit which can be heard over the corresponding flank [8], [10], 80% have cardiomegaly, 50% have signs of heart failure and 40% experience pain [8], [11].

Duplex ultrasound is a helpful diagnostic tool to evaluate the presence of an AVF. Prior to angiographic intervention, the diagnosis will nowadays usually be definitely confirmed by contrast-enhanced computed tomography or magnetic resonance imaging, if available.

Endovascular techniques have replaced open surgical repair as a first-line treatment for these challenging lesions [8]. Transcatheter embolization of large, high-flow arteriovenous fistulas carries a significant risk for migration of embolic material through the fistula and into the venous outflow and subsequently into the pulmonary arteries [12]. This risk should be minimized with the use of an AVP as described here. However, only a few cases have been described so far [13], [14], [15], [16], and relevant long-term data with respect to migration safety is not available.

Case report

A 63-year-old man was referred to us for intervention. The patient had undergone nephrectomy approximately 45 years earlier due to unmanageable hemorrhage after a bicycle accident during adolescence. Besides that, he had an unremarkable patient history and no regular medication. He complained of gradual progressive dyspnea and pain in the right flank within the last six months. Clinical examination and auscultation revealed a thrill and a systolic-diastolic bruit in the right flank. The patient had an elevated resting heart rate of 90 beats per minute at normal blood pressure. Duplex ultrasound of the right flank demonstrated typical findings of an AV-shunt with high peak systolic velocity and an irregular influx into the inferior vena cava. There were no previous imaging exams available in patient history showing or excluding a fistula. Diagnosis of a giant AVF (5 mm) between the right residual renal artery and the inferior vena cava, combined with an aneurysm (36 x 24 x 28 mm) of the right renal pedicle was obtained by contrast-enhanced computed tomography (Figure 1).

Institutional review board approval is not required at our institution for single-patient case reports.

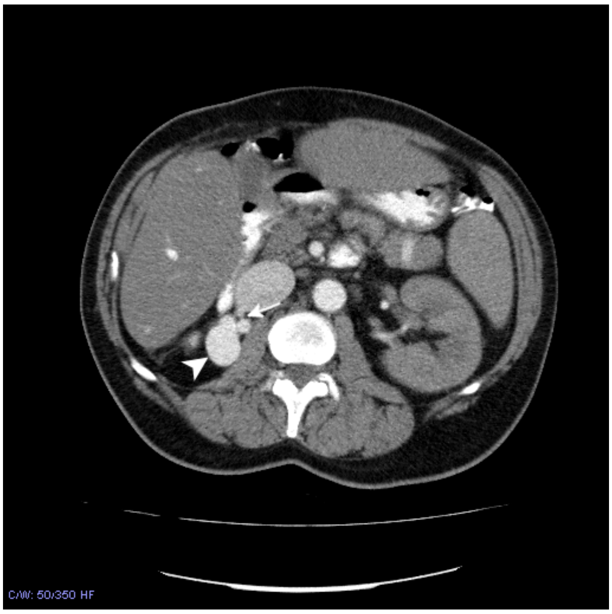

Figure 1: A 36 mm aneurysm (arrowhead) of the residual right renal artery combined with a giant AVF (arrow) between the right renal artery and the inferior vena cava was diagnosed by computed tomography. Note the increased opacity of the inferior vena cava during the arterial phase due to torrential flow from the artery to the vein.

The right common femoral artery was accessed in a retrograde fashion and a 5-F introducer sheath (Terumo Europe, Leuven, Belgium) was placed with Seldinger technique under local anaesthesia. An aortogram with power injection (15 ml/sec) via a 5F Nylex Pigtail Catheter (Cordis, Bridgewater, NJ, USA). Contrast agent: Imeron 300, Bracco, Konstanz, Germany) confirmed an aneurysm of the distal right residual renal artery and a giant AVF between the aneurysm and the inferior vena cava (Figure 2).

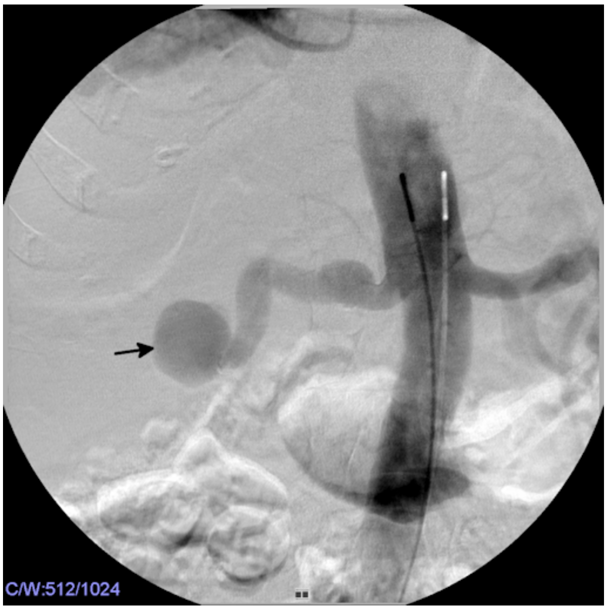

Figure 2: The aortogram confirmed the large aneurysm (arrow) of the right renal pedicle.

The introducer sheath was exchanged for a 6-F peripheral guiding sheath ("Destination", Terumo), which was passed into the renal artery for selective angiography. Again, antegrade right renal arteriography demonstrated an aneurysmatic and tortuous residual right renal artery with torrential flow from the renal artery to the inferior vena cava via the residual renal vein (Figure 3).

The fistula was carefully probed with a long hydrophilic guide wire (0.035", 260 cm, "Radiofocus", Terumo), which could eventually be steered through the tortuous, aneurysmatic vessel segments with a hydrophilic 5 F cobra catheter ("Glidex", Boston Scientific, Natick, MA, USA) and passed through the AV fistula into the inferior vena cava. However, it was not possible to establish a stable position of the catheter within the tortuous aneurysm and fistula for the intended AVP embolization.

Therefore, a 5F introducer sheath (Terumo) was inserted into the right common femoral vein and the fistula was transvenously tried to probe. Again, it was not possible to place a catheter through the fistula, although several catheter shapes (cobra (Boston Scientific), rim (Cook Medical, Bloomington, IN, U.S.A) and Simmons sidewinder Sim 1 & 2 (Cordis)) were used.

Eventually, the transarterial hydrophilic guide wire was snared with a snare catheter ("Amplatz Gooseneck", ev3 Europe, Paris, France) via the common femoral vein to obtain through-and-through guide wire access (Figure 4).

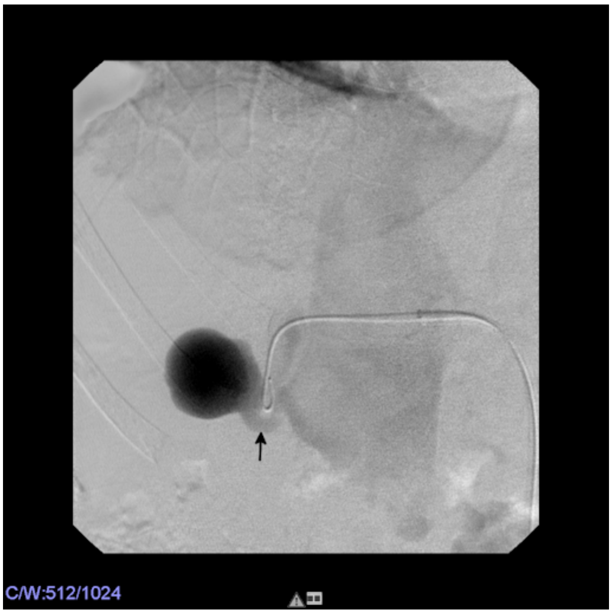

Figure 3: Selective angiography of the residual right renal artery demonstrates the giant AVF to the truncated renal vein (arrow) and inferior vena cava, which is visualized by contrast agent.

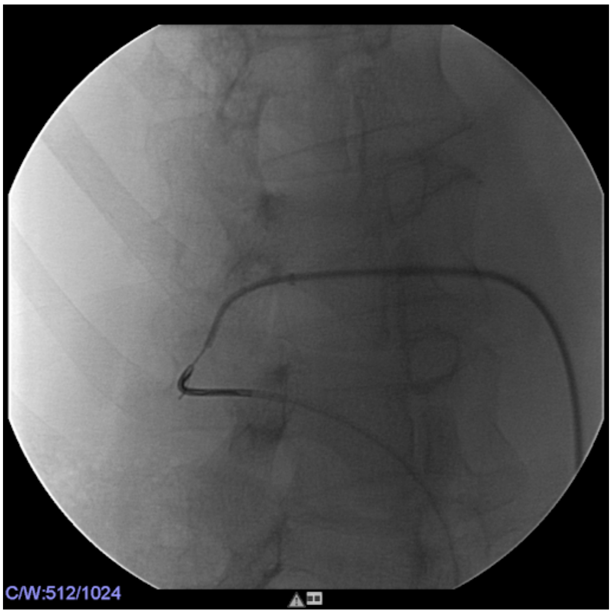

Figure 4: Through-and-through, i.e. arteriovenous guide wire access via the right common femoral artery and the right common femoral vein

This maneuver was followed by careful placement of a 5 F Berenstein catheter (Cordis) within the AVF via the transvenous access. After angiographic confirmation of correct position, an Amplatzer vascular plug IV, 7 mm (St. Jude Medical, St. Paul, MN, USA) was deployed within the venous segment of the AVF and completely occluded the fistula (Figure 5).

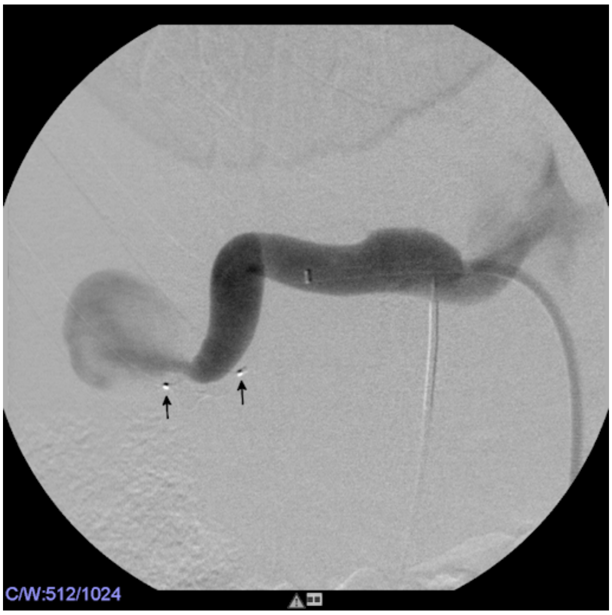

Figure 5: The venous segment of the AVF was occluded by deployment of an AVP IV, 7 mm. The radiopaque markings of the AVP are clearly visible (arrows). Note that the fistula is completely sealed by the occluder, the inflow into the aneurysm of the renal artery (upstream of the AVP) is overprojected with the AVP.

Subsequent embolization of the right renal artery was carried out by deployment of an Amplatzer vascular plug II, 16 mm (St. Jude Medical) via the transarterial introducer sheath in place. The final aortogram revealed successful embolization of both, the AVF and the right renal artery (Figure 6).

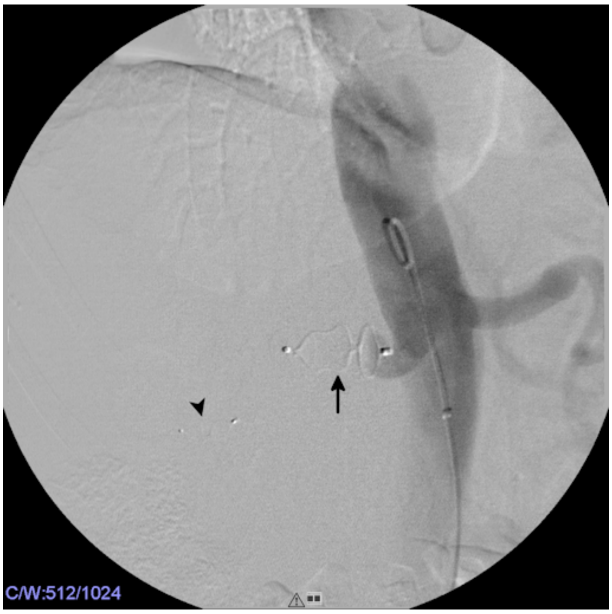

Figure 6: The final aortogram revealed successful embolization of the AVF and exclusion of the aneurysm. Contours and radiopaque markings of the AVP II, 16 mm (arrow) and the AVP IV, 7 mm (arrowhead) are clearly visible.

Following removal of introducer sheaths, the right common femoral artery was sealed (6F AngioSeal STS, St. Jude Medical), while the right common femoral vein was compressed.

The patient was immobilized for 4 hours and received perioperative intravenous antibiosis (1.5 g cefuroxim). He was discharged home the next day with a normal heart rate and made an unremarkable recovery. A computed tomography confirmed successful, complete embolization and correct location of the vascular plugs after 4 months (not shown).

Discussion

As in our case, development, or at least, diagnosis of renal arteriovenous fistulas is occasionally achieved late, some cases have been reported up to 40 years after nephrectomy (mean 14.5 years) [8].

Regarding the detailed pathophysiology and cellular biology of the spontaneous development of acquired arteriovenous fistulas, a literature research did not reveal a generally accepted, experimentally proven explanation. However, it is known, that shear stress exerted to endothelial cells is necessary for a vessel to remain in tubular shape and that a lack of shear stress, i.e. lack of laminar flow parallel to the endothelium, leads to the formation and growth of aneurysms [17]. Furthermore, the spontaneous development of aortocaval fistulas is a well-known complication of aortic aneurysms [18]. In these cases, the pulsating aortic aneurysm constitutes a physical stimulus of inflammation and leads to subtle arrosion of the wall of the inferior vena cava.

The development of a giant arteriovenous fistula originating from a blunt-ended, ligated renal artery subsequent to nephrectomy is probably just another variation of the same theme. Similar to the lack of shear stress to the wall of an aortic aneurysm, no shear stress is exerted to the “dead-end” of the residual renal pedicle and this seems to be a predisposition to the formation of aneurysms. One step further, the pulsating aneurysm grows and thus, the ligated renal artery gets in contact with the vena cava or the residual renal vein and arrosion of the venous vessel wall is initiated. Finally, the lumina of both, artery and vein begin to communicate with each other and thus, fistula genesis is complete.

Another explanation for the development of AVFs is simply focal inflammation of the adventitia of vein and/or artery caused by physical irritation during surgery that leads to fibrinous attachment of the walls of adjacent artery and vein. It is known that inflammation due to other stimuli such as syphilitic infection of the aortic wall constitutes an etiology for the development of aortocaval fistulas [19].

The reported existence of renal arteriovenous fistulas without the presence of an aneurysm of the renal artery may be explained by the latter theory.

However, in most cases, it remains unknown whether the fistula was present immediately after surgery and was just diagnosed up to several decades later due to increasing shunt volume, or whether the fistula itself develops

up to several decades later. The increasing availability of computed tomography and magnetic resonance imaging will enable clinicians to observe the genesis of AVFs in more detail.
It is now widely accepted that transcatheter embolization of giant AVFs has become first-line treatment with the benefits of decreased morbidity and shorter hospital stay [8]. Numerous techniques and embolization materials have been reported for the endovascular treatment of renal AV fistulas, which were summarized elsewhere [12], [14]. Some of these techniques address the significant risk for migration of embolic material through the fistula and into the venous outflow by use of additional material such as an Amplatz spider device to keep additional embolizing coils in place.
Resnick et al. established an arteriovenous through-and-through access via the right internal jugular vein and the right common femoral artery to deploy a constrained Wallstent within the AV fistula to hold embolizing coils in place despite continued antegrade flow through the initial coil pack [12].
In our case, the use of AVPs was thought to minimize the risk of dislodgement.
The deployment of these self-expanding plugs is precisely controllable, since they can be recaptured into the catheter in case of unsatisfactory position, thus minimizing the risk of migration. After correct positioning of the plug has been confirmed by a test injection of contrast agent through the catheter, the plug can then be detached from the pusher-wire in a relatively precise, controllable, intentional fashion by rotating the pusher wire.
One drawback is that it cannot be introduced over a guide wire, but must be introduced through a catheter that has to be advanced distal to the embolization site [14].
In our case, stable catheter placement for an AVP embolizing manoeuvre was not feasible via the single transarterial approach. Only the through-and-through arteriovenous guide wire provided sufficient stability to safely introduce the catheter through the AV fistula. Remarkably, the fistula was then completely occluded by AVP deployment from a transvenous catheter.
For additional safety and to avoid future growth of the aneurysm, we decided to embolize the renal artery stump by another AVP, but this may have been unnecessary.
A very similar approach was used by Brountzos et al. [14] to seal an iatrogenic AVF with a diameter of 7 mm between the renal artery and renal vein.

Conclusions

Our case report demonstrates the successful treatment of a symptomatic giant postnephrectomy arteriovenous fistula by use of Amplatzer vascular plugs. It suggests an alternative, safe method to seal symptomatic AVFs. In certain cases only a through-and-through, arteriovenous guide wire provides sufficient stability and guidance to safely introduce a catheter for deployment of an AVP. This bidirectional approach should be considered for future treatment of similar cases.

Notes

Competing interests

The authors declare that they have no conflicts of interest and no financial relationships with companies named in this manuscript.

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