Cardiovasc Intervent Radiol
DOI 10.1007/s00270-010-0047-0

CASE REPORT

# Endovascular Management of Complex Renal Artery Aneurysms Using the Multilayer Stent

**Carsten Meyer · Frauke Verrel · Gunther Weyer · Kai Wilhelm**

Received: 25 August 2010 / Accepted: 29 October 2010


**Abstract** Since its approval as an innovative stent system for peripheral aneurysm management in May 2009, the Cardiatis Multilayer Stent (Cardiatis, Isnes, Belgium) has been applied in several clinical cases. The unique design of this multilayer stent decreases mean velocity and vorticity within the aneurysm sac immediate and causes thrombus to form, resulting in physiological exclusion of the aneurysm from the circulation, whereas branches and collaterals sprouting from the aneurysm remain patent. Here we present a case of a complex renal artery aneurysm successfully treated with a 6 × 30-mm Cardiatis Multilayer Stent.

**Keywords** Arterial intervention · Embolization/ Embolisation/ Embolotherapy · Endovascular Aneurysm Repair/ Endovascular Aortic Repair · Endovascular Treatment · Artery · Kidney/Renal · Aneurysms

C. Meyer (✉) · G. Weyer · K. Wilhelm
Department of Radiology, University of Bonn,
53129 Bonn, Germany
e-mail: carsten.meyer@ukb.uni-bonn.de

G. Weyer
e-mail: gunther.weyer@ukb.uni-bonn.de

K. Wilhelm
e-mail: kai.wilhelm@ukb.uni-bonn.de

F. Verrel
Department of Surgery, University of Bonn,
53129 Bonn, Germany
e-mail: frauke.verrel@ukb.uni-bonn.de

## Introduction

Renal artery aneurysms (RAAs) are rare, with the prevalence through to be approximately 0.3 to 1.3% in the general population and 2.5% in hypertensive patients [1–3]. The mean age of patients is 60.6 years (range of 4–85). Aneurysm size ranges from 0.5 to 8 cm [1]. These aneurysms may be detected incidentally by noninvasive imaging evaluation, or patients may present with attendant symptoms and signs of complications, including hypertension, thrombosis, renal infarction, dissection, and rupture ([4–6]. RAA rupture does occur in 5% of known aneurysms and is more likely in aneurysms >2 cm and in noncalcified aneurysms [7]. Therefore, treatment is commonly recommended for symptomatic aneurysms, rapidly expanding aneurysms, and aneurysms >2 cm in diameter ([2]. Although stent-grafts and stent-plus-coil embolization techniques are successful for most simple renal artery aneurysms [8], complex aneurysms occurring beyond the bifurcation of the main renal artery, or aneurysms involving major arterial branches, may require extracorporal arterial reconstruction followed by autotransplantation [2].

Decrease of intra-aneurysmal flow by implanting special designed multilayer stents is considered an attractive new alternative for treating these complex aneurysms [9, 10]. The immediate decreases in mean velocity and vorticity within the aneurysm sac causes thrombus to form, resulting in physiological exclusion of the aneurysm from the circulation, whereas branches and collaterals sprouting from the aneurysm remain patent [11, 12].

In this article, we report the successful use of an innovative multilayer self-expanding stent device as an alternative to open surgery in a complex renal artery aneurysm involving a major arterial branch.

## Case Report

A 74-year-old man was incidentally found to have a 26-mm left renal artery aneurysm on magnetic resonance angiography performed for peripheral arterial vascular disease and was admitted to our hospital for surgical aneurysm exclusion.

The patient, who complained about symptoms of intermittent claudication, had additional risk factors (smoking, hypertension, and dyslipidemia). His serum urea and creatinine levels were within normal limits. Diagnostic left renal angiography demonstrated a complex renal artery aneurysm with a large mid-branch artery arising from the aneurysm sac (Fig. 1). In a multidisciplinary consensus, endovascular management of the renal artery aneurysm was preferred to avoid complex surgical therapy, and the option of an endovascular procedure with a new multilayer stent system was explained to the patient, who gave written consent before undergoing interventional therapy.

Digital subtraction angiography (DSA) was performed using a right femoral approach. A 45 cm-long, 6F sheath (Check-Flo Introducer; Cook, Bloomington, IN) was introduced, and the left renal artery was engaged with a 5F Cobra catheter (Cook) and a 0.035-inch hydrophilic guidewire (Terumo, Tokyo, Japan). Aneurysm morphology was obtained using conventional angiography and flat-panel computed tomography (CT) (Fig. 2). Stent diameter and length was determined from a three-dimensional (3D) flat-panel rotational angiography data set. After administration of 5000 IU heparin, the aneurysm was crossed with the guidewire and catheter. The wire was exchanged by way of the same catheter with a 0.035-inch Amplatz Super Stiff guidewire (Boston Scientific, Natick, MA). Finally, a 6 × 30-mm Cardiatis multilayer stent (Cardiatis, Isnes, Belgium) was deployed, bridging the aneurysm and covering the mid-branch artery (Fig. 3). Immediate postinterventional angiogram showed decreased blood flow inside the aneurismal sac, and flat-panel CT obtained 20 minutes after stent deployment demonstrated complete exclusion of aneurysm flow from renal perfusion with preserved mid-branch artery flow. The patient was discharged the next day and prescribed 100 mg acetylsalicylic acid and 75 mg clopidogrel/d as platelet antiaggregators.

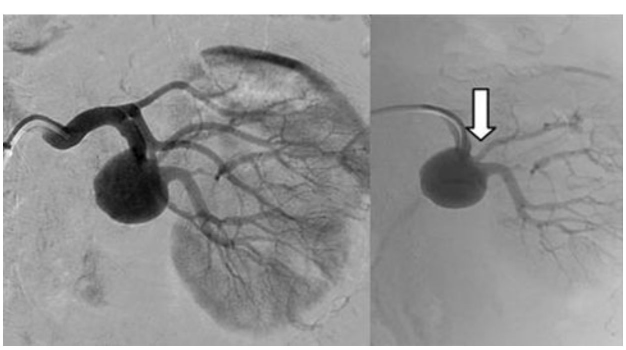

**Fig. 1** Selective left renal artery angiography before stent implantation shows aneurysm with large mid-branch artery (*arrow*) arising from the aneurysm sac

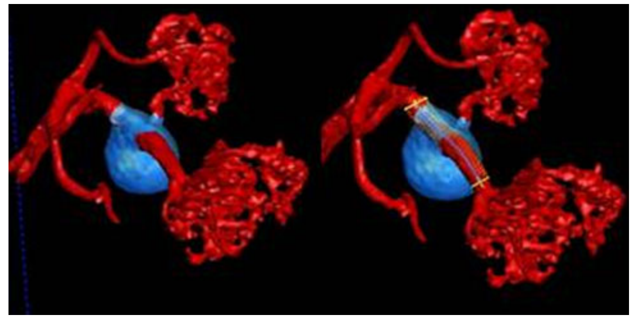

**Fig. 2** 3D rotational angiography used for measurement and therapy planning demonstrates size and location of the aneurysm (*blue/light grey*) in correlation to the large mid branch artery arising from the aneurysm sac

**Fig. 3** A 6 × 30-mm multilayer stent was deployed, covering the mid-branch artery arising from the aneurysm sac

Computed tomography angiography (CTA) performed 30 days and again 5 months after stent implantation showed exclusion of the aneurysm sac with patent renal artery and mid-branch artery, no signs of renal infarction, and stable aneurysm size (Fig. 4). Follow-up angiography performed 3 months after stent implantation demonstrated patent flow inside the stent and the mid-branch artery without evidence of in-stent stenoses or aneurysm sac perfusion (Fig. 5).

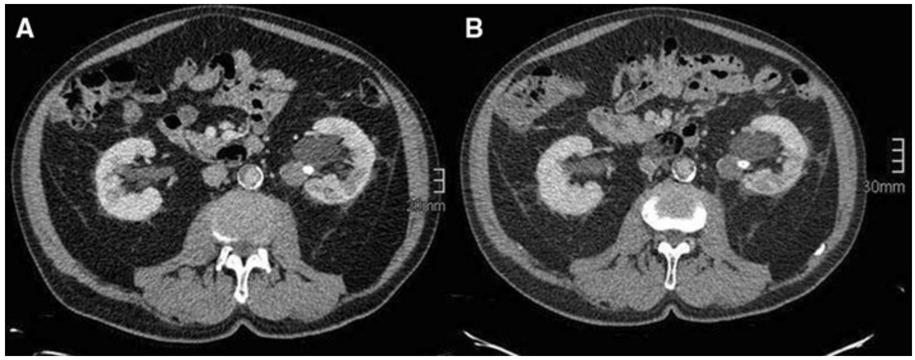


**Fig. 4** Follow-up CTA performed 30 days (**A**) and 5 months (**B**) after multilayer-stent implantation shows exclusion of the aneurysm sac with stable aneurysm size

**Fig. 5** Follow-up angiography performed 3 months after multilayer-stent implantation: no obstruction or in-stent stenosis occurred during anticoagulation therapy, and the mid-branch artery is patent and the aneurysm sac still excluded

## Discussion

RAAs are now discovered with greater frequency due to increased use of noninvasive imaging modalities. In most cases, the clinical relevance of these incidentally diagnosed RAAs is uncertain, and a debate exists regarding a threshold for RAA repair. There is a consensus that repair should be performed in patients with RAAs >2 or 2.5 cm or in patients with enlarging RAAs, symptomatic RAAs (flank pain, hypertension, hematuria), RAAs with documented distal embolization, RAAs with associated significant stenosis or malperfusion [4, 13–16]), and RAAs in pregnant women or women of childbearing age. Demonstrating an incidentally diagnosed 26-mm RAA, our patient fulfilled the indication of aneurysm repair, leaving open the question open surgical versus endovascular repair.

Many different surgical repair techniques exist, including open surgical repair (aneurysmectomy with renal artery bypass or autotransplantation), laparoscopic repair, and robot-assisted laparoscopic RAA reconstruction [17–19]. Even surgical repair techniques avoiding organ ischemia have been published [20]. However, morbidity and long recovery periods persist in cases of open surgical repair, and aortorenal bypass occlusions and unplanned nephrectomies occur even in the largest series. Additionally, some patients may not be candidates for surgical repair because of coexistent morbidities that prohibit surgery or because of complex aneurysm morphology or aneurysm location.

In these patients, interventional minimal invasive procedures remain an alternative to surgery. Various percutaneous approaches have already been reported using stent grafts [21, 22] or different embolization techniques, such as coil embolization [23] or embolization with liquid embolic agents [24].

Stent-grafts have restricted use in the treatment of RAA because of inflexibility or high-profile devices making it impossible to navigate in tiny or tortuous vessels or because of coverage of important branches, leading to renal infarction. Due to the existence of a mid-branch artery arising from the aneurysm sac and tortuous vessel anatomy, a stent-graft was not a therapeutic alternative in our case.

Different embolic techniques (such as selective coil embolization), remodelling techniques (including balloon- and stent-assisted coiling), and embolization with liquid embolic agents (such as glue or onyx) exist and represent in selected patients the first-line treatment option for RAA. However, also in these techniques it is sometimes necessary to perform a parent vessel occlusion to treat the aneurysm with some grade of renal parenchyma compromise.

Flow-diverter stents have been developed for endovascular treatment of intracranial aneurysms, and today two such stent systems are available: the Pipeline stent and the Silk stent. Although the Pipeline stent represents a safe, durable, and curative treatment of selected wide-necked, large, and giant intracranial aneurysms [25], preliminary experience with the Silk stent showed quite high delayed clinical and anatomic complication rates with significant parent artery stenoses in 33% of cases [26]. This emphasizes the importance of adequate double antiplatelet therapy. Additionally, the Silk stent presented another major limitation in terms of unpredictable aneurysm occlusion.

The Cardiatis multilayer stent is a new type of flow diverter stent consisting of two interconnected layers without any coverage. leading to decreased turbulent flow velocity in the aneurysm sac while improving laminar flow in the main artery and its branches. The stent is made of a biocompatible cobalt alloy wire, is available in diameters from 2 to 50 mm, and can be loaded in small (6F) delivery systems. Due to the low-profile stent characteristic and complex aneurysm morphology, we decided to implant this stent in our patient. The interventional procedure was finished without any complications and with proven exclusion of aneurysm sac perfusion after 20 minutes. The postinterventional course was uneventful, and control CTA and DSA demonstrated a patent stent, vital branch, and stable aneurysm size.

## Conclusion

Transcatheter embolization is a commonly employed technique in treating aneurysms. The basic principle of current techniques for endovascular repair is to exclude aneurysms from the circulation either through packing with coils or by using covered stents as mechanical barriers. Unfortunately, sole coil filling of aneurysm is not possible in wide-neck and complex aneurysms, and commercially available stent grafts used to exclude fusiform aneurysms are difficult to deploy in tortuous vessels. Additionally, obstruction of side branches and disruption of vital collaterals might occur. The low-profile multilayer stent seems to be a new promising tool to provide interventional radiologists the opportunity to treat complex visceral and peripheral aneurysms even with short landing zones, bifurcations or artery branches, and tortuous vessel anatomy. However, the Cardiatis multilayer stent must prove its clinical effectiveness not only by inducing progressive aneurysm thrombosis alone but also by demonstrating aneurysm size shrinkage or stabilization. Further studies with longer follow-up are needed to evaluate the place of this new device in aneurysm therapy.

**Conflict of interest** None.

## References


1. Porcaro AB, Migliorini F, Pianon R et al (2004) Intraparenchymal renal artery aneurysms. Case report with review and update of the literature. Int Urol Nephrol 36(3):409–416
2. Gallagher KA, Phelan MW, Stern T et al (2008) Repair of complex renal artery aneurysms by laparoscopic nephrectomy with ex vivo repair and autotransplantation. J Vasc Surg 48(6):1408–1413
3. Klein GE, Szolar DH, Breinl E et al (1997) Endovascular treatment of renal artery aneurysms with conventional non-detachable microcoils and Guglielmi detachable coils. Br J Urol 79(6): 852–860
4. Martin RS 3rd, Meacham PW, Ditesheim JA et al (1989) Renal artery aneurysm: selective treatment for hypertension and prevention of rupture. J Vasc Surg 9(1):26–34
5. Chen R, Novick AC (1994) Retroperitoneal hemorrhage from a ruptured renal artery aneurysm with spontaneous resolution. J Urol 151(1):139–141
6. Meabed AH, Onuora VC, Al Turki M et al (2002) Rupture of a renal artery aneurysm in pregnancy. Urol Int 69(1):72–74
7. Hageman JH, Smith RF, Szilagyi E et al (1978) Aneurysms of the renal artery: problems of prognosis and surgical management. Surgery 84(4):563–572
8. Xiong J, Guo W, Liu X et al (2010) Renal artery aneurysm treatment with stent plus coil embolization. Ann Vasc Surg 24(5):695.e1
9. Ohta M, Wetzel SG, Dantan P et al (2005) Rheological changes after stenting of a cerebral aneurysm: a finite element modeling approach. Cardiovasc Intervent Radiol 28(6):768–772
10. Augsburger L, Farhat M, Reymond P et al (2009) Effect of flow diverter porosity on intraaneurysmal blood flow. Klin Neuroradiol 19(3):204–214
11. Henry M, Polydorou A, Frid N et al (2008) Treatment of renal artery aneurysm with the multilayer stent. J Endovasc Ther 15(2):231–236
12. Balderi A, Antonietti A, Pedrazzini F et al (2010) Treatment of a hepatic artery aneurysm by endovascular exclusion using the multilayer cardiatis stent. Cardiovasc Intervent Radiol 33(6): 1282–1826
13. English WP, Pearce JD, Craven TE et al (2004) Surgical management of renal artery aneurysms. J Vasc Surg 40(1):53–60
14. Malacrida G, Dalainas I, Medda M et al (2007) Endovascular treatment of a renal artery branch aneurysm. Cardiovasc Intervent Radiol 30(1):118–120
15. Trocciola SM, Chaer RA, Lin SC et al (2005) Embolization of renal artery aneurysm and arteriovenous fistula—a case report. Vasc Endovascular Surg 39(6):525–529
16. Ufberg JW, McNeil B, Swisher L (2003) Ruptured renal artery aneurysm: an uncommon cause of acute abdominal pain. J Emerg Med 25(1):35–38
17. Thomas AA, Shields WP, Hamdi Kamel M et al (2006) Renal artery aneurysm treated with ex vivo repair and autotransplantation. Surgeon 4(4):245–247
18. Gill IS, Murphy DP, Hsu TH et al (2001) Laparoscopic repair of renal artery aneurysm. J Urol 166(1):202–205
19. Luke P, Knudsen BE, Nguan CY et al (2006) Robot-assisted laparoscopic renal artery aneurysm reconstruction. J Vasc Surg 44(3):651–653
20. Trunfio R, Demertzis S, van den Berg JC et al (2008) A new surgical approach for exclusion of renal artery aneurysms avoiding organ ischemia. Eur J Vasc Endovasc Surg 36(5):559–561
21. Liguori G, Trombetta C, Bucci S et al (2002) Percutaneous management of renal artery aneurysm with a stent-graft. J Urol 167(6):2518–2519
22. Bisschops RH, Popma JJ, Meyerovitz MF (2001) Treatment of fibromuscular dysplasia and renal artery aneurysm with use of a stent-graft. J Vasc Interv Radiol 12(6):757–760
23. Karkos CD, D'Souza SP, Thomson GJ et al (2000) Renal artery aneurysm: endovascular treatment by coil embolisation with preservation of renal blood flow. Eur J Vasc Endovasc Surg 19(2):214–216

24. Abath C, Andrade G, Cavalcanti D et al (2007) Complex renal artery aneurysms: liquids or coils? Tech Vasc Interv Radiol 10(4):299–307
25. Lylyk P, Miranda C, Ceratto R et al (2009) Curative endovascular reconstruction of cerebral aneurysms with the pipeline embolization device: the Buenos Aires experience. Neurosurgery 64(4):632–642 (discussion 642–633; quiz N636)
26. Lubicz B, Collignon L, Raphaeli G et al (2010) Flow-diverter stent for the endovascular treatment of intracranial aneurysms: a prospective study in 29 patients with 34 aneurysms. Stroke 41(10):2247–2253