

## Amplatzer Vascular Plug in Renal Artery Embolization: Case Serial and Review of the Literature

Billy Karundeng,<sup>1</sup> Richard Sumangkut,<sup>1</sup> Yuansun Khosama,<sup>1</sup> Djonny E. Tjandra,<sup>1</sup> Michael D. Winarto<sup>2</sup>

<sup>1</sup>Division of Vascular and Endovascular Surgery, Department of Surgery, Medical Faculty, Universitas Sam Ratulangi - Prof. Dr. R. D. Kandou Hospital, Manado, Indonesia

<sup>2</sup>Specialist Study Program of Department of Surgery, Faculty of Medicine, Universitas Sam Ratulangi – Prof. Dr. R. D. Kandou Hospital, Manado, Indonesia

Email: myemailoremail@gmail.com

*Received: June 1, 2023; Accepted: September 11, 2023; Published online: September 13, 2023*

**Abstract:** Embolization constitutes a safe and effective therapeutic possibility in the treatment of numerous renal pathologies whether election or urgency. The use of Amplatzer vascular plug (AVP) constitutes a more recent and less widespread therapeutic choice, and its use in the renal district is not yet widespread although potentially very valid. Perioperative renal artery embolization has been introduced to reduce the risk of oncological spread and intraoperative bleeding, in order to facilitate surgery, thus decreasing perioperative morbidity. Nevertheless, in recent literature the real usefulness of perioperative renal artery embolization is still debated. Some authors agree that the advantages of perioperative renal artery embolization are to decrease intraoperative bleeding with a lower transfusion rate and to reduce operative time. Therefore, we presented five cases of renal arterial embolizations (RAEs) performed with AVP from July to August 2022 at Prof. Dr. R. D. Kandou Hospital, Manado. In all cases, a single plug was used which perfectly adapted to the target artery resulting in complete occlusion of the vessel within a short period of time. Renal artery embolization was generally performed the day before surgery under local anesthesia. After confirmation of the tumor vascularization with a contrast study, the selective renal artery embolization was performed. In our experience, the use of AVP for the treatment of renal arteriovenous fistula and neoplastic masses had given excellent results without any complications during and after the treatment. In conclusion, RAE performed with AVP has growing potential and numerous advantages in terms of the time of the procedure, speed of embolization, and precision of occlusion, but with a relative increase in costs.

**Keywords:** amplatzer vascular plugs; vascular surgery; endovascular surgery; renal artery embolization

**INTRODUCTION**

Renal mass is any growth in the kidney that can be benign or cancerous; however most masses do not cause symptoms. Imaging modalities such as CT, MRI, or ultrasound are used to diagnose such masses. Renal artery embolization is performed before radical nephrectomy (RN) for renal mass in order to induce preoperative infarction and to facilitate surgical intervention through decrease of intraoperative bleeding.<sup>1</sup>

Arteriovenous fistulas (AVFs) present with a variety of symptoms, including high output cardiac state (HOS, featuring tachycardia, heart congestion, and dyspnoea), refractory hypertension, hematuria, abdominal pain, and flank bruits.<sup>2</sup> The usual treatment is surgery, consisting of legation of arterial feeder, nephrectomy, or partial nephrectomy.<sup>3</sup> Albeit, endovascular treatment can now be considered as an alternative.<sup>4</sup>

Nevertheless, in huge and complex renal masses, which are often characterized by a high and anarchic blood supply and rapid local invasion, radical nephrectomy can be challenging even for skilled surgeons. Benefits of renal artery embolization (RAE) in the preoperative setting are decrease in perioperative blood loss, creation of a tissue plane of edema facilitating dissection, and reduction in tumor bulk including extent of vascular thrombus, when present. The plugs represent a vascular occlusion system initially used at the cardiological pathologies (foramen ovale or DIA occlusion) and extended in the peripheral area with the necessary structural changes. Since 2004, it has been approved for the clinical use of Amplatzer vascular plug (AVP) exclusively dedicated to peripheral vascular structures. Its use in the renal district is not yet widespread although potentially very valid.<sup>5</sup>

The use of AVP constitutes a more recent and less widespread therapeutic choice, and its use in the renal district is not yet widespread although potentially very valid.<sup>6,7</sup> Therefore, this case serial study aimed to prove that embolization is a safe and effective therapeutic possibility in the treatment of various renal pathologies in selection and in urgency.

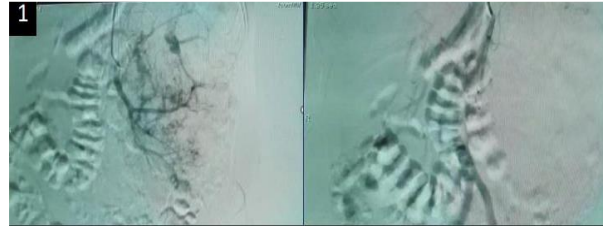
**CASE SERIAL REPORT**

We presented five renal arterial embolization cases performed with AVP in July-August 2022 at Prof. Dr. R. D. Kandou Hospital, Manado. Three patients had right kidney tumors, and two patients had left kidney tumors. These five patients were consulted from the Urology Division for renal artery embolization before radical nephrectomy. The diagnoses of kidney tumors are based on, as follows: anamnesis, a palpable lump in the abdomen or waist are on the right or left accompanied by pain; physical examination of the abdomen: in inspection, visible lump in the right abdomen; auscultation, normal peristaltic sound of bowel; palpation, palpable masses with various sizes, hard, and mobile; percussion: tympanic, but can be silent in the tumor area. The urological status consisted of: CVA (bulging +/+), ballotement (-/-), knock pain (-/-), supra pubic (full bladder (-)), tenderness (-), external urethral orifice (discharge (-)), and catheter (-). The patients were also measured for kidney size and a CT scan with contrast a few days before and after embolization of kidney. Table 1 showed the characteristics and diagnoses of the five patients in this study. Figure 1-5 showed the deployment of AVP in each patient meanwhile Figure 6 showed the change of kidney size pre and post embolization in patient 5.

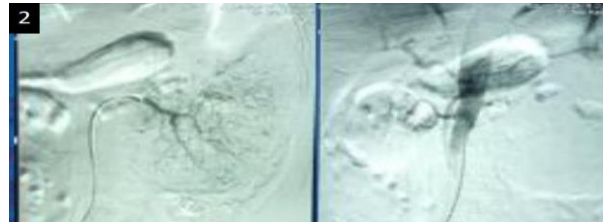
**Table 1.** Distribution of patients including sex, age, and diagnosis

Initials	Sex	Ages (yrs)	Diagnosis
AP	Male	40	Left kidney tumor suspect teratoma
AT	Male	55	Left kidney tumor suspect RCC
MV	Female	46	Right kidney tumor suspect RCC
RM	Male	46	Right kidney tumor suspect RCC
SM	Female	61	Right kidney tumor suspect RCC

RCC, renal cell carcinoma



**Figure 1.** Patient 1. Deployment of AVP 10x8 mm on the left renal artery. Renography was performed 20 minutes later, and no visible contrast filled the left kidney



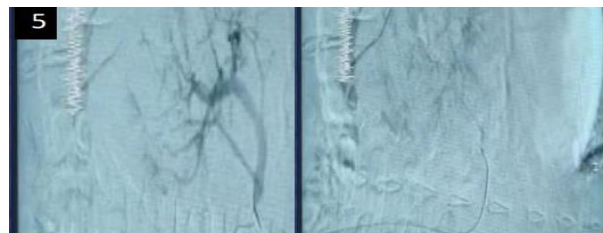
**Figure 2.** Patient 2. Deployment of AVP 14x8 mm on the left renal artery was carried out. Renography was performed 20 minutes later on the left kidney with unvisualized aortography



**Figure 3.** Patient 3. Deployment of AVP 10x8 mm in the right renal artery



**Figure 4.** Patient 4. Deployment of AVP 12x7 mm in the right renal artery



**Figure 5.** Patient 5. Deployment of AVP 10x8 mm in the right renal artery



**Figure 6.** Patient 5. A, Size of kidney: 18 cm x 12 cm pre embolization; B, Size of kidney 11 cm x 7 cm post embolization

## DISCUSSION

Renal artery embolization was generally performed the day before surgery under local analgesia. After confirmation of the tumour vascularization with a contrast study, the selective RAE was performed. Perioperative RAE has been introduced to reduce the risk of oncological spread and intraoperative bleeding, in order to facilitate surgery, thus decreasing perioperative morbidity.<sup>8</sup>

Embolization of the renal artery represents the gold standard of acute bleeding. It is a valid support in the treatment of tumor renal mass and in the therapeutic management of hypervascularized renal tumor, but is also strongly recommended in the case of vascular malformations.<sup>4</sup>

Indications for embolization in the therapeutic management of neoplastic renal masses include palliative care for mass loss and bleeding risk in candidates for total or partial nephrectomy or radioablation treatment, as well as control of hematuria and/or bleeding within and before and after active injury. Non-traumatic renal bleeding is a rare event, but it can be very life-threatening. The goal of treatment is to relieve recurrent hematuria, circulatory system overload, hypertension, and hemodynamic abnormalities. It is also important to maintain functional nephrons as much as possible.<sup>9</sup>

Prior to the use of endovascular embolization, it was surgically treated with arterial reconstruction and partial or total nephrectomy, along with arterial reconstruction and partial or total nephrectomy. However, there was a risk of kidney parenchyma and loss of function with surgery. In current practice, most of the renal arteriovenous fistulae (AVF) is treated with endovascular embolization to preserve renal function, as well as the function of nephrons. The first endovascular embolization techniques were reported in the 1970s, where autologous blood clots were used for embolization.<sup>5</sup> Over time, several other types of embolics were used, such as polyvinyl alcohol, gel foam sponges, steel coils, cyanoacrylates, and most recently, the use of vascular plugs. Embolization should target the abnormal feeding artery, trying not to affect the normal renal artery. Therefore, it has to be considered which part of the nutrient artery to occlude.<sup>10</sup>

Other few cases presented the use of an AVP for the embolization of kidney arteriovenous fistula.<sup>8,11,12</sup> In particular, Perkov et al<sup>12</sup> used a 12 mm AVP II released in the main artery feeding straight the arteriovenous fistula of the right kidney, while Kayser et al<sup>4</sup> deployed a 7 mm AVP IV within the venous segment of the AVF and then they occluded the right renal artery with a 16 mm AVP II. In Perkov case, the occluded artery fed only the AVF without parenchymal contributions, meanwhile in Kayser case, they performed a sort of endovascular nephrectomy.<sup>4,12</sup>

The use of AVP for renal artery embolization for the treatment of neoplastic mass has shown an excellent result without finding any complications during and after the interventional procedure.<sup>1,13</sup> Renal artery embolization performed with AVP is used as a surgical adjunct to facilitate radical nephrectomy by decreasing intra-operative blood loss. This RAE performed with AVP has growing potential and numerous advantages in terms of the time of the procedure, speed of embolization, and precision of occlusion.<sup>14,15</sup>

The prospective randomized study showed pre-operative renal artery embolization to be a safe procedure with relatively low complications rate. To our experience, pre-operative renal artery embolization seemed to be a useful tool in surgical management of huge mass and advanced disease. However further prospective studies with larger sample size and longer follow up are necessary to confirm our results.

Nevertheless, in recent literature the real usefulness of perioperative renal artery embolization is still debated. Some authors agree that the advantages of Perioperative Renal Artery Embolization are to decrease intraoperative bleeding with a lower transfusion rate and to reduce operative time.

## CONCLUSION

As renal artery embolization has the potential to benefit increasing numbers of patients, it is imperative for the interventionalist to be well versed with renal artery embolization techniques.

### Conflict of Interest

The authors affirm no conflict of interest in this study.

### REFERENCES

1. Campbell JE, Davis C, DeFate BP, Tierney JP, Stone PA. Use of an Amplatzer vascular plug for transcatheter embolization of a renal arteriovenous fistula. *Vascular*. 2009;17(1):40–3.
2. Hongsakul K, Bannangkoon K, Boonsirat U, Kritpracha B. Transarterial embolization of a renal artery aneurysm concomitant with renal arteriovenous fistula. *Vasc Endovascular Surg*. 2018;52(01):61–5.
3. Kalman D, Varenhorst E. The role of arterial embolization in renal cell carcinoma. *Scand J Urol Nephrol*. 1999;33(3):162–70. Doi: 10.1080/003655999750015934.
4. Kayser O, Schafer P. 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. *Ger Med Sci (GMS)*. 2013; 11:Doc01. Doi: 10.3205/000169.
5. Wang H, Wang J, Song L, Lv T, Tong X, Zou Y. Superselective renal artery embolization for bleeding complications after percutaneous renal biopsy: a single-center experience. *J Int Med Res*. 2019;47(4):1649–59. Doi: 10.1177/0300060519828528.
6. Cantera D, Kutikova A, Manleya B. Utility of the R.E.N.A.L.-nephrometry scoring system in objectifying treatment decision-making of the enhancing renal mass. *Urology*. 2011;78(5):1089–94.
7. Choe J, Shin JH, Yoon HK, Ko GY, Gwon DI, Ko HK, et al. Safety and efficacy of transarterial nephrectomy as an alternative to surgical nephrectomy. *Korean J Radiol*. 2014;15(4):472–80.
8. Basri N, Yusoff BM, Samsudin AHZ, Mohamad N, Nadarajan C, Abdullah MS. Trans-arterial embolization of high-flow renal arteriovenous fistula (AVF) with concomitant renal artery aneurysm. *Journal of Clinical Interventional Radiology (ISVIR)*. 2023;07(01):060-3. Available from: <https://doi.org/10.1055/s-0042-1744533>.
9. Ramaswamy RS, Darcy MD. Arterial embolization for the treatment of renal masses and traumatic renal injuries. *Tech Vasc Interv Radiol*. 2016;19(3):203–10.
10. Schwartz MJ1, Smith EB, Trost DW, Vaughan ED Jr. Renal artery embolization: clinical indications and experience from over 100 cases. *BJU Int*. 2007;99(4):881–6.
11. Marumo 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;36:0000–0000.
12. Perkov D, Novacic K, Novosel L, Knezevic N. Percutaneous embolization of idiopathic renal arteriovenous fistula using Amplatzer vascular plug II. *Int Urol Nephrol*. 2013;45(1):61–8. Available from: <https://doi.org/10.1007/s11255-012-0358-y>.
13. Chatziioannou A, Mourikis D, Kalaboukas K, Ladopoulos Ch, Magoufis G, Primetis E, et al. Endovascular treatment of renal arteriovenous malformations. *Urol Int*. 2005;74(1):89–91. Available from: <https://doi.org/10.1159/000082716>
14. Carrafiello G, Laganà D, Peroni G, Mangini M, Fontana F, Mariani D, et al. Gross hematuria caused by a congenital intrarenal arteriovenous malformation: a case report. *J Med Case Rep*. 2011;5(1):510. Available from: <https://doi.org/10.1186/1752-1947-5-510>
15. Catelli A, Loiudice G, Corvino A, Bracale UM, Quarantelli M, Venetucc P. Amplatzer vascular plug in renal artery embolization: case report and review of the literature. *Egypt J Radiol Nucl Med*. 2020;51:158. Available from: <https://doi.org/10.1186/s43055-020-00279-y>