



SHORT ORIGINAL ARTICLE / *Cardiovascular imaging*

Selective arterial embolization of life-threatening renal hemorrhage in four patients after partial nephrectomy



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KEYWORDS

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Urogenital
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Abstract

Purpose: Partial nephrectomy (PN) is an accepted alternative to radical nephrectomy for nephron sparing surgery to treat renal tumors. Although complications are relatively rare after PN, they may include renal hemorrhage that can be massive and life threatening. Artery embolization can have a major role in the management of these cases and to avoid radical nephrectomy.

Materials and methods: We report four consecutive patients with massive hemorrhage after PN, treated by arterial embolization and review the literature to discuss the clinical presentation, imaging evaluation and clinical outcome. All patients developed arteriovenous fistula and one a pseudoaneurysm.

Results: After selective catheterization and identification of the bleeding site, we used micro-coils as embolization material. Immediate technical and clinical success was achieved in all cases.

Conclusion: Superselective artery embolization of renal hemorrhage is a simple, safe and efficient procedure. It has a high clinical success and should be considered as an alternative to nephrectomy, minimizing the morbidity and preserving renal tissue.

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The improvement of imaging techniques has led to the increased discovery of asymptomatic renal tumors [1–3]. Radical nephrectomy has traditionally been the standard treatment for renal cell carcinoma, but some studies showed that PN yields the same cure rates as radical nephrectomy [4,5]. Today the accepted indications for PN have been expanded and include unilateral lesions in patients that have a normal contralateral kidney [4] or tumors that deeply invade the renal parenchyma and might affect the collecting system [5]. The main advantages of PN compared to radical nephrectomy is to reduce the risk of chronic kidney disease insufficiency when controlled for risk factors [6] and with maintained similar oncologic outcomes, associated to a decrease in overall mortality and non-cancerous related death due to the lesser impact in cardiac and renal status [2]. Because of this, PN has become a standard of care as a nephron sparing surgery in some cases [7]. Laparoscopic PN is an alternate option to open surgery and in experienced hands can reduce morbidity for selective patients [7].

However, PN is a more challenging procedure with higher morbidity rate [2]. The most frequent complications are perioperative bleeding and urinary fistula [2]. Pseudoaneurysms and arteriovenous fistula (AVF) are uncommon after minimally invasive partial nephrectomy, but can lead to significant morbidity and are potentially life threatening [8–10]. Other techniques are used in the treatment of renal tumors. Radiofrequency ablation can be an efficient alternative solution, less invasive than surgery. It can also have vascular complications although no life-threatening complications were reported [11].

Embolization has been used in various clinical situations related to renal cancer since 1973, including preoperative aid to the resection of localized renal tumors and a means to palliate the symptoms of metastatic disease [12]. One of the major complications of PN can be life-threatening hemorrhage. The purpose of this paper is to report our experience in emergency embolization of four consecutive patients.

Materials and methods

We retrospectively reviewed our cases of urgent arterial embolization after a life-threatening hemorrhage following partial nephrectomy. No approval from the hospital was needed. We included four patients treated in our department from June 2010 until September 2011. Three men and one woman (age range 38–83 years, median 59.5 years) underwent partial nephrectomy for tumorectomy. The first two were diagnosed as clear cell carcinomas, the third was an angiomyolipoma and the fourth patient had a renin-secreting tumor. This last rare case was diagnosed based in the laboratory values (plasmatic renin 130.5 μ U/L; plasmatic aldosterone 1490 pmol/L; urinary aldosterone 81 nmol/24 h an urinary cortisol 593 nmol/24 h) as well as on pathology with cells expressing renin, actine alpha, CD34 and viomentin.

They developed renal hemorrhage postoperatively (range 3–9 days after surgery) with significant hemodynamic perturbations. Macroscopic hematuria was the most common sign, present in three patients and flank pain was also observed in three patients. No one had coagulopathy. Pre-intervention imaging included CT and US with Doppler

before the arterial angiogram. Complete blood count, mean systolic and diastolic blood pressure were recorded before embolization. Before embolization, hemoglobin levels were 8 g/dL, 8.5 g/dL, 7.5 g/dL and 11.5 g/dL with need of transfusion of 2 units in the first two cases and 5 units of red blood cells in the third patient.

Using the Seldinger technique, we placed a 4Fr or 5Fr sheath in the right common femoral artery after local anesthesia of the groin (Lidocaine 2%). We performed a global aortogram using a pigtail catheter. This first evaluation allowed the identification of renal arteries anatomy as well as to identify the exact bleeding vessel responsible for the hemorrhage. Catheterization of the homolateral renal artery and superselective access using a Progreat microcatheter 2.7Fr (Terumo, Tokyo, Japan) was performed. The bleeding site was identified in all cases and we used as embolization material tornado® coils with a size range of 2 \times 3 mm to 2 \times 4 mm (Cook, Bjaeverksov, Denmark) and 2 \times 2 mm and 3 \times 2 mm (Azur, Terumo, Tokyo, Japan). The endpoint for embolization was complete occlusion of the bleeding vessel and most efforts were paid to save as much as possible of normal remaining renal parenchyma. Immediate technical success was defined as the ability to stop the angiographic bleeding with absence of flow in the target bleeding vessels. Immediate clinical success was defined as normalization of BP and pulse rate, interruption of clinical bleeding, absence of need of more blood cell transfusion and absence of need for re-embolization or nephrectomy. Clinical follow-up was obtained in all patients.

Results

In all four patients, immediate angiography showed the site of extravasation of contrast as well as an AVF (Figs. 1–6). One patient had a renal pseudoaneurysm. Immediate technical and clinical results were achieved in all cases. No one has post-embolization syndrome. Patient 1 had a history of bilateral pulmonary embolism that required an IVC filter insertion (Fig. 7). We observed in one patient a transient increase of serum creatinine levels that returned to the pre-embolization level after 48 hours. All patients were discharged with restored normal red blood count and normal renal function. Patient 1 had a urinary tract infection (UTI) that was clinical managed with target antibiotherapy with complete resolution. During the post-embolization period, the remaining renal parenchyma showed normal perfusion and no significant damage was observed immediately after and at follow-up examinations, using CT and with follow-up ranged 2–12 months (Figs. 8–10). No major complications were observed immediately after or during the follow-up period.

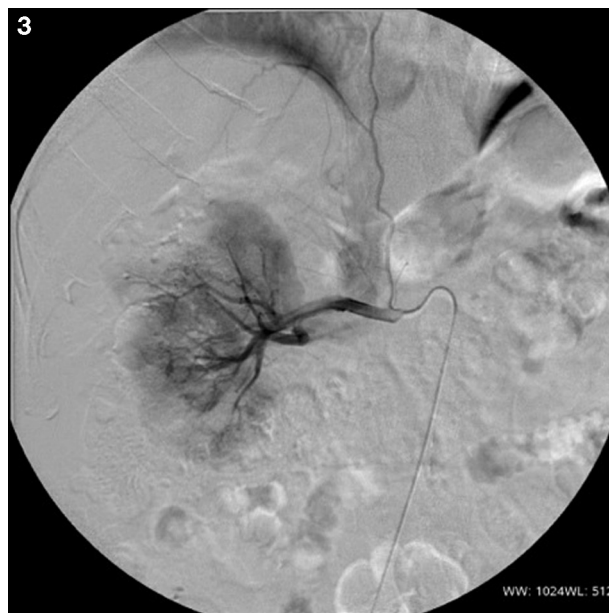
Discussion

After selective embolization of all four cases, immediate technical and clinical results were observed. No one had major complications. A life-threatening hemorrhage is considered a significant blood loss in the kidney collecting system or in the perirenal space, causing hemodynamic instability [13]. An AVF that does not represent itself the



Figures 1 and 2. Selective renal angiogram of patient 1 showing a bleeding area on the left kidney (day 9 after surgery).

bleeding site helps in mapping the exact site of the arterial trauma. Occluding the parent vessel as close as possible to the site of the fistula is the best technique to stop the bleeding [14], while saving as much as possible the remaining renal parenchyma (Figs. 11–14). We generally use 0.018' coils, delivered through a microcatheter, because we consider this is the best tool to ensure permanent occlusion at a very specific arterial point. The Tornado® (Cook, Bjaev-erksov, Denmark) coils, thanks to their cone shape, allow satisfactory packing of the vessel and reduce the risk of incomplete occlusion related to partial clotting of the vessel. The use of coils is largely accepted in these cases [2,3,7,8] but the site of deposition is considered a very important issue, as it should totally occlude the bleeding vessel to prevent recurrence. No significant change in renal



Figures 3 and 4. Patient 2 with bleeding area on the right kidney demonstrated on the angiogram.

function was observed before and right after the procedure in our patients, but renal dysfunction occurred in one patient in the post-embolization period. This fact can be due to the direct nephrotoxic effect of contrast media and/or because of ischemia of renal parenchyma after embolization. Embolization of larger segments can be safer to control hemorrhage but it leads to a larger ischemia in these clinical situations [14].

The embolization can be performed using a variety of embolic agents: autologous blood clot, detachable balloons, coils, particles and *N*-butyl-2-cyanoacrylate. Glue would allow very fast closure of the parent artery but carries the risk of reflux in non-desired branches, especially when a less trained IR is in charge. We reserve it currently to very severe arterial trauma where there is basically no time to wait for the coil occlusion. In these not frequent situations, a single



Figure 5. Bleeding area in the middle and inferior left kidney in patient 3.

shot of glue (i.e. 0.1 mL of Glubran (GEM, Viareggio, Italy) diluted in half with Lipiodol (Guerbet, France)) would perfectly do the job. Gelatine sponge particles are also possible materials with the potential of secondary re-opening within a few days, which can be an advantage in the nephron sparing process. In the mean time, the risk of re-bleeding is not null and we consider that in these life-threatening situations, the potential advantage is not worth the risk. Onyx (ev3, Irvine, CA, USA) can also be used but due to its cost and to the simple alternative that coils may provide, we reserve it to other more anatomically challenging situations. Microparticles should be avoided because the lesion is either

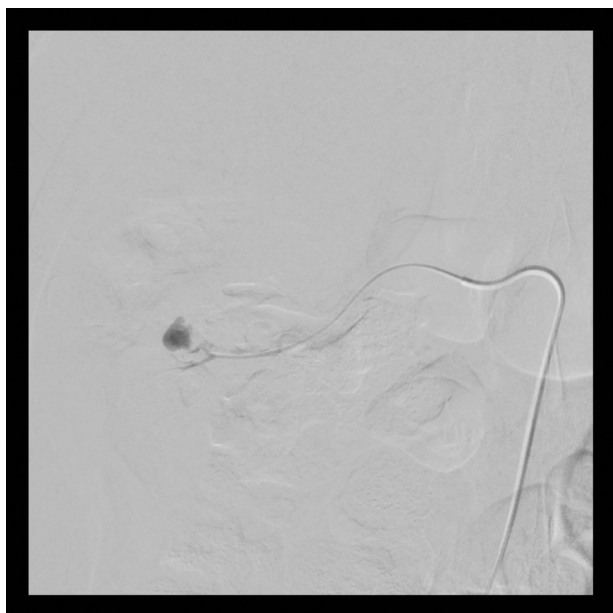


Figure 6. Patient 4 with hemorrhagic area in the middle third of right kidney.



Figure 7. A pre-angiography CTA performed in patient 1 with a IVC filter and a bleeding area visible in patient 1.

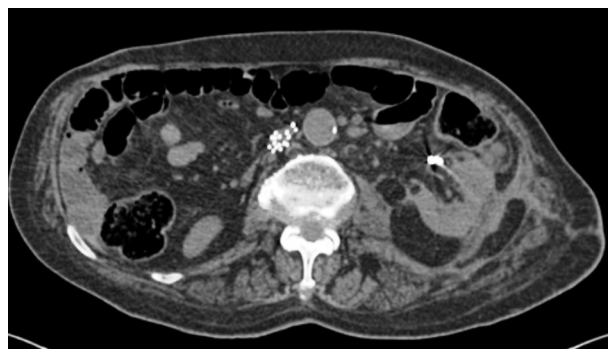


Figure 8. Control CTA after embolization with coils demonstrated in patient 1.

an AVF or a pseudoaneurysm and that particles will not only be inefficient but will carry a significant risk of undesired venous passage.

Renal life-threatening hemorrhage is a major complication of PN but is also very rare [13]. It can be immediate

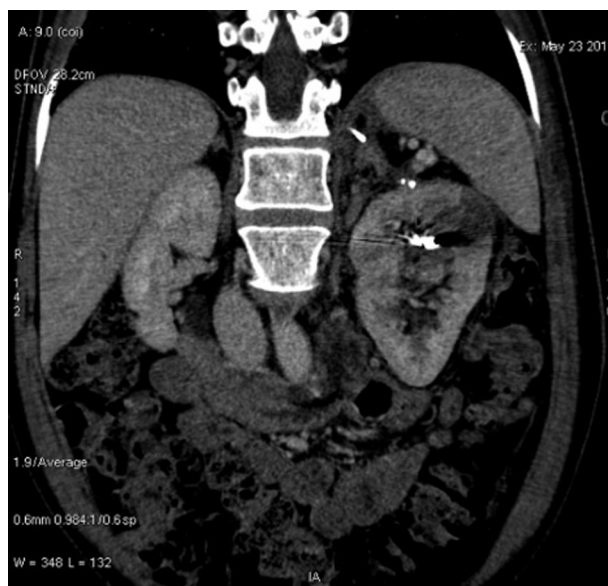


Figure 9. Three months after embolization CTA with good technical and clinical result in patient 3.

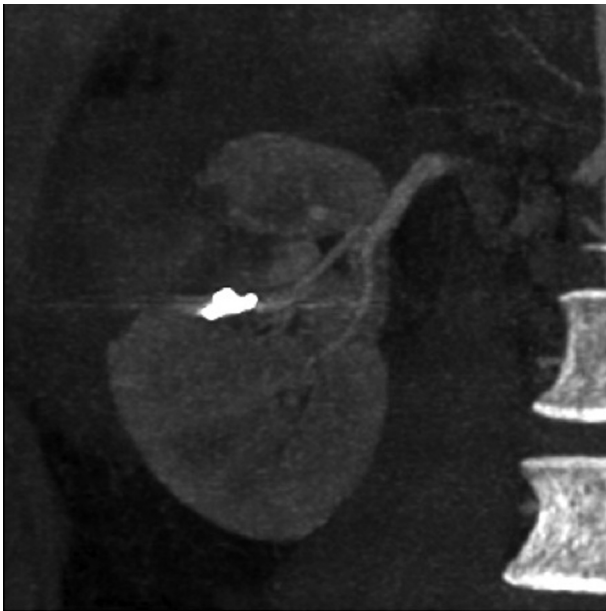


Figure 10. Post-embolization imaging showing the microcoils in patient 4.

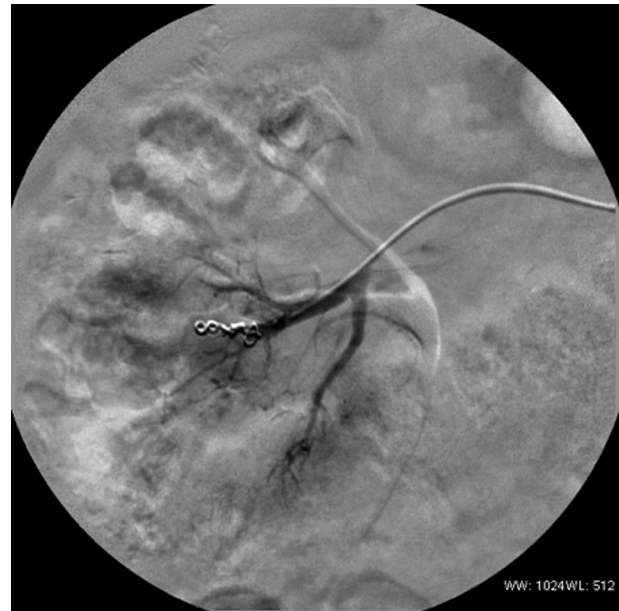


Figure 12. Selective microcoil deposition with good technical result in patient 2.

or delayed after a couple of weeks or several months and may have severe consequences [15–17]. Nevertheless, it occurs most frequently some days after the procedure with the development of AVF and/or intra-parenchymal artery aneurysms. In our institution, four patients developed severe hemorrhage. Three of them had gross hematuria, the most important visible sign of renal hemorrhage. When persistent, levels of hemoglobin must be measured, hemodynamic changes may occur and blood transfusion may also be needed. The development of perirenal hematomas is

responsible for flank pain that is also very common and may lead to renal dysfunction. Urinary tract infections are other major complication when fever is observed and the adequate treatment should not be postponed. Renal dysfunction is often seen before the procedure but can also be consequence of ischemia and use of contrast media during embolization in a susceptible postoperative kidney. Imaging of the injured kidney in the postoperative period is challenging.

On one hand, the accurate diagnosis comprising the positive diagnosis of bleeding, the anatomical of both the



Figure 11. Coil deposition at the hemorrhagic area and final angiogram showing the complete resolution of the renal hemorrhage in patient 1.



Figure 13. Embolisation with microcoils and complete resolution of the renal hemorrhage in patient 3.

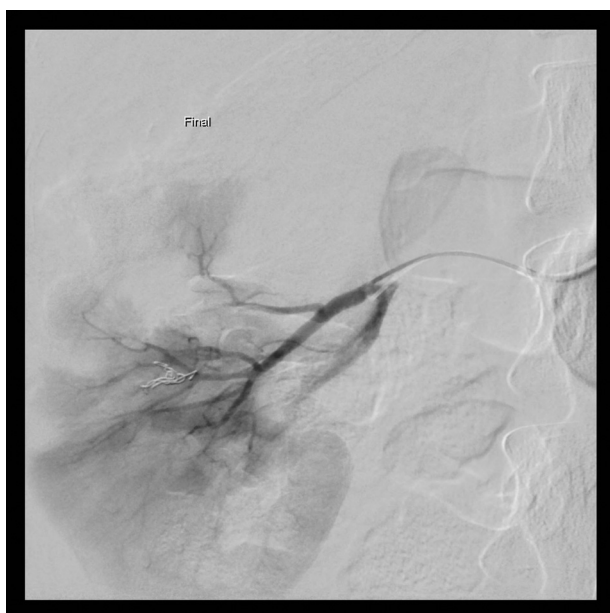


Figure 14. Complete embolisation in the final angiogram in patient 4 as demonstrated.

bleeding site and the bleeding lesion would be rapidly obtained. On the other hand, the patient is just recovering from renal surgery and has an increased risk of renal failure in case of contrast media injection. Ultrasound examination with Doppler can be very valuable as a screening tool, offering rapid access, possible confirmation of the renal hematoma and, sometimes thanks to color duplex, the nature of the arterial injury. Unfortunately an experienced operator is not always available during out-of-hours service and duplex only yields the diagnosis of renal hematoma.

The need for CTA is debated: visualization of acute bleeding at the arterial phase is sometimes considered an indication for emergent embolization. Considering that related to the clinical/surgical history, the location of the bleeding is very likely to be in the operated kidney, one can consider CTA as an unnecessary step because it will increase the contrast media dose to the patient and because angiography and embolization will be needed anyway. A negative examination should never avoid further investigation if clinical suspicion is high [2]. CT was also performed as pre-interventional evaluation in our cases (Fig. 15). In cases of renal dysfunction, the use of nephrotoxic contrast media should be avoided. In these cases, the use of ultrasound and MR are more suited as imaging options. Embolotherapy has been reported as a high success rated procedure in the majority of casuistics and reports used in our review. Identification of the exact bleeding site can be very challenging before and during the procedure.

We used in all cases a global angiogram because the bleeding site can lie in various parts of the kidney. The arterial variations are frequent and preoperative arterial mapping is not always available. Moreover, other non-renal branches may also be the cause for bleeding, especially intercostals or lumbar arteries that could be injured because of the pneumoperitoneum and the abdominal wall access points.



Figure 15. Pre-angiogram CTA showing the bleeding area in patient 4.

The variable anatomy of renal vasculature can limit technical success and bleeding from another site can happen after the embolization of the first arterial branches. This last fact represents a technical difficulty and the coil deposition site is very important to avoid recurrence [5]. Recurrence of bleeding is also a technical problem, and it could just be seen after the procedure due to spasm of the renal branches at the catheterization site. A second intervention must be considered if a minor bleeding is observed or in more severe situations, the last option is open surgery with nephrectomy. Although it is a safe procedure, renal embolization has some potential complications. Apart of groin hematomas, infection, we would like to highlight coil migration and non-target embolization even if they are rare. A very common complication is post-embolization syndrome, particularly with complete embolization [14].

In the literature, we can find just small casuistics or case reports of these situations but most of them are not life-threatening conditions (Tables 1 and 2).

In all cases, the indication for selective embolization was bleeding after PN with pseudoaneurysms and AVF. In the majority of the cases, CT with CTA was the chosen imaging method, but US is also reported as a good method to demonstrate perirenal blood or organized collections. When comparing the data from the literature, we see that the main difference is the embolic material utilized. The references with more cases describe the use of microcoils as a standard to selectively embolize the bleeding site with clinical success. Nevertheless, we can also use other embolization materials in the management of massive renal hemorrhage.

We propose the use of superselective embolization as the first line treatment of haemorrhage after PN because it allows sparing the remaining kidney if performed adequately. In addition, it does not carry the risks of open surgery if a nephrectomy needs to be performed including general anaesthesia. Angiography is now available in most units and the identification of bleeding is possible with this technique. As it is a minimal invasive approach, morbidity is lower comparing with open surgery.

Table 1 Clinical, imaging and laboratory findings in the group of patients.

Patient	Age	Gender	Clinical findings	Histology	Hemoglobin before/after (g/dL)	Creatinine before/after (μmol/L)	Days post-surgery	Angiographic findings	Embolization material (Coils)
1	83	M	History of bilateral pulmonary embolism, IVC filter UTI: <i>E. coli</i> and <i>Klebsiella</i> Inferior pole of left kidney nodule	Clear cell carcinoma	8.0/12.1	98/114	9	Contrast extravasation from an ascending branch of renal artery + AVF + pseudoaneurysm in descending branch	2 × 5 (n = 2) 2 × 4 (n = 1)
2	55	M	Trifocal tumorectomy at inferior pole of right kidney	Tubulopapillary clear cell carcinoma	8.5/11.6	155/129	3	AVF of inferior branch	2 × 3 (n = 3)
3	64	F	Superior right kidney nodule	Angiomyolipoma	7.5/12.0	78/83	8	AVF inferior branch	2 × 3 (n = 3)
4	38	M	Superior pole right kidney	Renin-secreting carcinoma	11.5/13.2	111/122	8	AVF Inferior branch	2 × 2 (n = 2) 3 × 2 (n = 1)

Table 2 Literature review of cases reports and series of patients.

Reference	Imaging Diagnosis	Embolization Cases (n)	Imaging Findings	Material	Success
Hyams et al. (multicentric) [8]	CTA	16	Pseudoaneurysms and AVF	Platinum Microcoils	16/16
Guiu et al. [9]	CTA	1	Pseudoaneurysms after PN	N-butyl-2-cyanoacrylate	1/1
Baumann et al. [5]	CTA, US, MRA	5	Pseudoaneurysm and AVF after PN	Microcoils	4/5
Ciudin et al. [13]	CTA, US, angiography	3		Microcoils	3/3
Netsch et al. [7]	Angiography	6	Pseudoaneurysms after PN	Microcoils	6/6
Zeleňák et al. [18]	CT	1	Pseudoaneurysm + AVF	Onyx	1/1
Ghoneim et al. [2]	CTA	15	Pseudoaneurysm + AVF	Microcoils	11/15
Hidas et al. [19]	CTA	1	Pseudoaneurysm	Coils	1/1
Current experience	CTA, US, Doppler	4	Pseudoaneurysms and AVF	Microcoils	4/4

Conclusion

Selective arterial embolization in renal hemorrhage following partial nephrectomy is a relatively simple procedure and has high rates of angiographic and clinical success. It should be considered as a minimal invasive treatment, safe, efficient and a feasible alternative to emergent life saving nephrectomy.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

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