

## Original Article

# Renal angiography and artery embolization for treatment of bleeding after PCNL: analysis of 44 cases

Wen Song, Zhaohong Peng, Zhuang Xiong, Guobing Zhang, Bensheng Zhao, Mingquan Wang, Longxiang Tao, Jijia Zhu, Dezhi Zhang

Department of Interventional Radiology, The First Affiliated Hospital of Anhui Medical University, Hefei 230022, Anhui, P. R. China

Received July 1, 2019; Accepted September 3, 2019; Epub November 15, 2019; Published November 30, 2019

**Abstract:** Incidence rates of postoperative renal hemorrhaging after percutaneous nephrolithotomy (PCNL) procedures remain high. Interventional medicine plays an important role in the treatment of renal bleeding. However, results still need to be summarized. Forty-four patients that experienced bleeding after PCNL were enrolled in the current retrospective study. This study also conducted an analysis of interventional procedures used to control hemorrhaging. Application of embolization materials was used in accordance with the actual situation. Of the 44 patients experiencing bleeding after PCNL, 42 patients were found to have abnormal angiographic findings. Another 20 patients showed contrast medium spillover, accounting for 45.45%. A total of 20 patients were embolized using metallic coils plus gelatin sponges, accounting for 47.62%. In conclusion, angiography and embolization techniques are proven effective methods to control renal bleeding after PCNL.

**Keywords:** ANGIOGRAPHIC, embolization, percutaneous nephrolithotomy, renal

## Introduction

Prevalence of nephrolithiasis remains high in China. Percutaneous nephrolithotomy (PCNL) is one of the most preferred treatments for kidney stones [1]. However, incidence of postoperative renal hemorrhaging after PCNL is 0.71%, according to reports [2]. Traditional methods of dealing with massive hemorrhaging after PCNL include non-surgical conservative treatments, application of hemostatic drugs, clamping of a renal fistula, water sac compression by an extracorporeal fistula, extracorporeal traction, open surgery hemostasis, renal angiography, and super selective renal artery embolization hemostasis [2, 3]. Controlling severe bleeding was shown to be ineffective with conservative treatment, surgical partial nephrectomy, and disease-side nephrectomy procedures. According to past records, the surgical resection rate in response to bleeding is greater than 50%, even though such treatments have the disadvantages of extensive trauma and complications. More severely, some patients experience

poor renal function, further aggravating renal damage [4].

With the development of medical technological methods, Interventional Medicine has played an important role in the treatment of renal bleeding after PCNL [5]. Angiography procedures can both timely and accurately determine the location of the bleeding and the amount of bleeding. Embolization techniques have been successfully applied to stop bleeding, while maximizing renal function protection. Advantages of Interventional Medicine in the control of bleeding include simplicity of use, ease of control, and safety for patients, along with good reproducibility [6].

Therefore, with the wide application of Interventional Medicine in bleeding control after PCNL, additional experiences and questions must be summarized and shared. The current retrospective study of 44 patients experiencing renal hemorrhaging after PCNL, treated with artery embolization, may provide practical

# Artery embolization after PCNL

**Table 1.** Clinical characteristics of all patients

Clinical Category	Statistical Description
Age (Mean $\pm$ SD)	51.52 $\pm$ 13.31
Sex (Male/Female)	31/13
Location (Right/Left)	23 (52.27%)/21 (47.73%)
Angiographic findings (n)	
Contrast medium spillover	20 (45.45%)
Pseudoaneurysm	10 (22.73%)
Arteriovenous fistula	6 (13.64%)
Pseudoaneurysm + arteriovenous fistula	4 (9.09%)
Arterial laceration	2 (4.55%)
Negative angiographic finding	2 (4.55%)
Embollic material used (n)	
Gelatin sponge (GS)	6 (14.29%)
Polyvinyl alcohol (PVA)	6 (14.29%)
Metallic coils + PVA	10 (23.81%)
Metallic coils + GS	20 (47.62%)

experience for further diagnosis and treatment of these conditions.

## Materials and methods

### Cohort samples

Forty-four patients with nephrolithiasis after PCNL, from June 2009 to November 2018, were enrolled from the First Affiliated Hospital of Anhui Medical University (Hefei, China). Diagnostic evaluations were performed, separately, for each person using standardized criteria for diagnosing nephrolithiasis. All patients were diagnosed via spiral computed tomography (CT), ultrasonography, or X-ray procedures. Following diagnosis, the patients underwent PCNL and experienced bleeding. Next, interventional surgery was applied for further treatment.

The current retrospective study was conducted with the approval of the Ethics Committee of Anhui Medical University. All patients provided written informed consent for the use of their data in clinical research. Whether the participants had the capacity to consent was evaluated by the following criteria: 1) Ability to understand and reason; and 2) Ability to make rational decisions. It was necessary to perform magnetic resonance imaging or ultrasonography procedures, ascertaining the scope and position of the bleeding.

### Interventional procedures

Interventional procedures were performed in the Digital Subtraction Angiography (DSA) operating room through puncturing of the femoral arteries and placement of an 8F arterial sheath (Bard Medical Division, Covington, GA, USA), following local anesthesia using 2% lidocaine. A 4F or 5F Cobra catheter (Terumo Co., Ltd., Tokyo, Japan) was used to perform angiographies on the renal artery openings, aiming to identify the bleeding site. After guiding the catheter to the hemorrhagic branch artery, if necessary, a microcatheter super selective intubation was used to confirm that the catheter head was in the

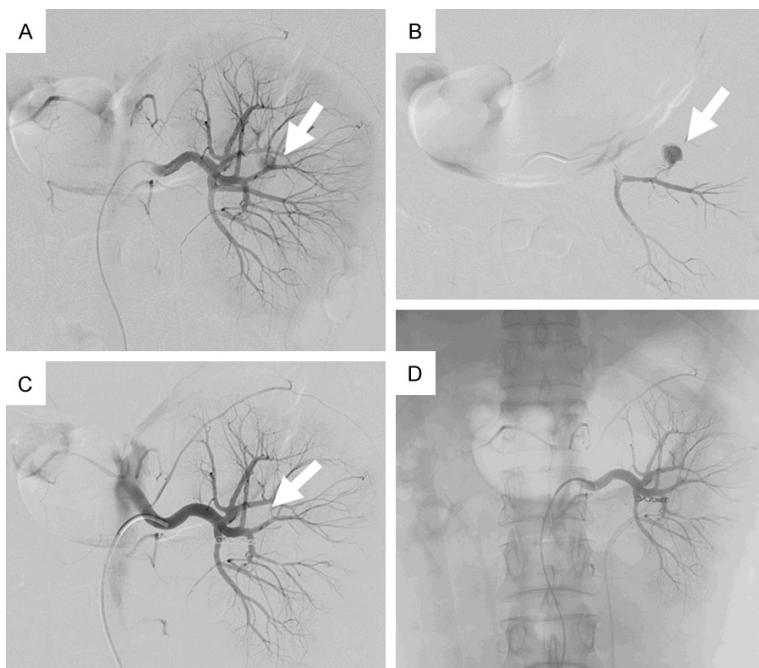
hemorrhaging artery orifice. A free coil was then injected, along with a gelatin sponge strip or a gelatin sponge pellet, through the catheter. The cobra or pigtail catheter was removed when the opening level of the renal artery was specified. Similarly, in other patients, a balloon catheter was placed into the abdominal artery using a guidewire with the balloon positioned below the level of the renal artery. Following X-ray fluoroscopies, the X-ray dose was recorded. After confirming via the renal angiography that there was no more renal hemorrhaging, the catheter and vascular sheath were removed. There was no spilling of contrast agent in confirming the effects of the embolization.

## Results

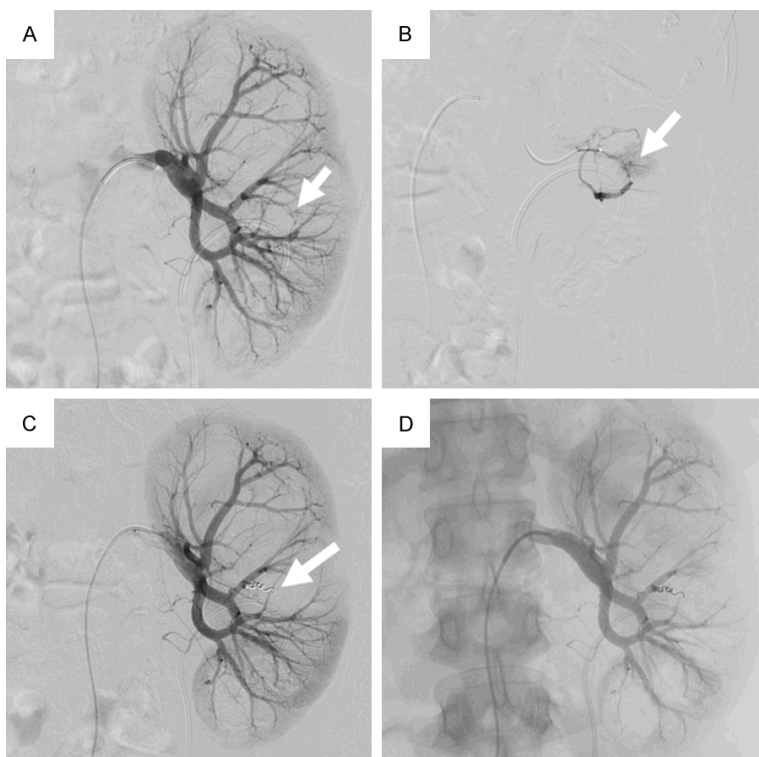
### Clinical features

Clinical characteristics of all patients are presented in **Table 1**, including 31 men and 13 women, with an average age of 51.52  $\pm$  13.31 years. Of the 44 patients, 42 patients were found to have abnormal angiographic findings (contrast medium spillover in 20 patients, pseudoaneurysm in 10 patients, arteriovenous fistula in 6 patients, pseudoaneurysm and arteriovenous fistula in 4 patients, and arterial laceration in 2 patients). However, 2 patients had negative angiographic findings. All patients underwent embolization and hemostasis. In all patients, hemostasis was successfully accom-

## Artery embolization after PCNL



**Figure 1.** Male, age 37, hematuria occurred after PCNL to treat left nephrolithiasis. Left renal artery angiography was performed in the emergency department. A. Pseudoaneurysm located in the left renal artery trunk; B. Super selective angiography shows the presence of the pseudoaneurysm; C. The pseudoaneurysm disappears after the embolization with metallic coils; D. The location of the kidney angiography relative to the spine.



**Figure 2.** Female, age 35, hematuria occurred after a right renal biopsy. A. The main renal artery angiography suggests that the right lower kidney

artery branch has developed an arteriovenous fistula; B. Use of microcatheter super selective angiography to further clarify the target vessel; C. The arteriovenous fistula disappears after the embolization with metallic coils; D. The location of the kidney angiography relative to the spine.

plished. Six patients were embolized with a gelatin sponge (GS), 6 patients were embolized with polyvinyl alcohol (PVA) particles, 10 patients were embolized with metallic coils and PVA, and 20 patients were embolized with metallic coils and GS.

### *Surgery operation*

One patient (male, age 37) had left arterial hemorrhaging after PCNL. A left renal artery angiography procedure was performed. Angiographic findings indicated that a pseudoaneurysm was in the left renal artery trunk (**Figure 1A**), supported by super selective angiography (**Figure 1B**). The hemorrhage was successfully treated with metallic coils (**Figure 1C**) and found in the left kidney relative to the spine (**Figure 1D**). Another case of right renal biopsy bleeding (arteriovenous fistula) was treated with metallic coils (**Figure 2**). After embolization, hemorrhaging occurred again on the third day after hemostasis. Hemostasis was performed again via digital subtraction angiography (DSA). No signs of renal hemorrhaging were found during the operation. No bleeding symptoms were found in the 42 cases after treatment and a hemorrhagic enzyme 2~3 U was injected for hemostasis. Thus, in the 42 cases, hemostasis was successful. The success rate of treatment was 100%.

## Artery embolization after PCNL

These patients were followed up for 1 to 24 months without any cases of recurrence.

### Discussion

In the current retrospective study, 44 patients experiencing bleeding after PCNL were treated with renal angiography and embolization procedures. The success rate of treatment was 100%. More importantly, these successfully treated hemostasis patients were followed up for 1 to 24 months with no cases of recurrence noted.

In different cases of damage, angiographic manifestations vary. They can be indicated as aneurysms, aneurysms with arteriovenous fistula, and contrast agent spillover. Patients in the current study mainly showed contrast medium spillover, accounting for 49.18%. Some patients experienced hemorrhaging due to medical hemostasis or clot blockage of hemorrhagic arterioles, resulting in no direct signs of hemorrhaging during renal angiographies. Retrospective analysis of the abovementioned contrast false negative cases found 2 cases with negative angiographic findings, accounting for 4.55%.

The anatomical basis of the renal artery is mostly a type, divided into two sections before and after the division of the 5 branch artery. Each renal artery has an independent blood supply area. There is almost no anastomosis between the arteries in each segment, providing an anatomical basis for super selective arterial embolization for renal hemorrhaging [7]. It can achieve immediate hemostasis, without easy relapse. Therefore, the embolization site should be located far away from the renal artery and close to the bleeding site, aiming to avoid recurrence and to maximize renal function protection [8]. During treatment, staff members should pay attention to the presence or absence of the accessory renal artery [9].

Selection of embolization methods includes several aspects. Arterial embolization materials include a gelatin sponge, steel ring, PVA, and NBCA glue. The most commonly used materials are gelatin sponges and spring coils [10]. The gelatin sponge, which can easily absorb blood, is a medium-effective embolization material [11]. Blood can be embolized with gelatin sponge. The spring coil is a permanent

embolization material. Different sizes of spring coils can be selected according to the diameter of the blood vessels [12].

Treatment of recurrent embolization can be difficult. Treatment principles include: (1) The embolization site should be as close as possible to the bleeding site and the use of permanent embolization material is necessary to reduce post treatment recurrences [13]; (2) When the vascular injury is associated with an aneurysm or an arteriovenous fistula, a spring coil embolization or a gelatin sponge, plus a spring coil embolization, is the best choice [14]; (3) To reduce normal renal parenchymal damage, PVA injected into the microcatheter embolization can be used to control peripheral vascular injuries and bleeding; and (4) The embolization material should be slowly injected under fluoroscopy. After injection, the blood flow is interrupted. The blood vessel should be occluded to avoid posttreatment recurrence caused by insufficient embolism or renal function damage [15].

In this group, 30 cases were treated with metallic coils plus PVA or metallic coils plus GS embolization. There was no recurrence after treatment. Six cases were treated with gelatin sponges and 6 cases were treated with polyvinyl alcohol alone. For patients with negative contrast, the use of vascular relaxants to increase the contrast dose can increase the positive rate of diagnosis [16]. If clinical bleeding is obvious and the contrast is negative, diagnostic vascular embolization can be performed on the puncture site to achieve hemostasis [17-21].

In summary, renal angiography can identify the location of renal hemorrhaging after PCNL. Advantages are that it is safe, minimally invasive, and effective. Furthermore, it leads to a good prognosis and fewer complications, as well as a quick recovery with maximum protection.

### Acknowledgements

Current project was supported by the National Natural Science Foundation of China (NO. 81801679).

All patients provided written informed consent for the use of their data in clinical research. The

## Artery embolization after PCNL

current study was approved by the Ethics Committee of Anhui Medical University.

### Disclosure of conflict of interest

None.

**Address correspondence to:** Dezhi Zhang, Department of Interventional Radiology, First Affiliated Hospital of Anhui Medical University, Hefei 230-022, Anhui, P. R. China. E-mail: hfzhangdezhi@126.com

### References

- [1] Asplin JR. Nephrolithiasis. *Nephrology Secrets*. Elsevier; 2012. pp. 123-130.
- [2] Ganpule AP, Vijayakumar M, Malpani A and Desai MR. Percutaneous nephrolithotomy (PCNL) a critical review. *Int J Surg* 2016; 36: 660-664.
- [3] Li L, Zhang Y, Chen Y, Zhu KS, Chen DJ, Zeng XQ and Wang XB. A multicentre retrospective study of transcatheter angiographic embolization in the treatment of delayed haemorrhage after percutaneous nephrolithotomy. *Eur Radiol* 2015; 25: 1140-7.
- [4] Saad WG and Mmdouh A. Pediatric PCNL puncture complication: risk factors. *Eur Urol* 2018; 17: e805.
- [5] Türk C, Petřík A, Sarica K, Seitz C, Skolarikos A, Straub M and Knoll T. EAU guidelines on interventional treatment for urolithiasis. *Eur Urol* 2016; 69: 475-82.
- [6] Milligan M and Berent AC. Medical and interventional management of upper urinary tract uroliths. *Vet Clin North Am Small Anim Pract* 2019; 49: 157-174.
- [7] Wang HL, Xu CY, Wang HH and Xu W. Emergency transcatheter arterial embolization for acute renal hemorrhage. *Medicine (Baltimore)* 2015; 94: e1667.
- [8] Ierardi AM, Duka E, Lucchina N, Floridi C, De Martino A, Donat D, Fontana F and Carrafiello G. The role of interventional radiology in abdominopelvic trauma. *Br J Radiol* 2016; 89: 20150866.
- [9] Ogeg' o JA, Masaki CO, Malek AA, Were FN, Olabu BO, Misiani MK and Murunga AK. Anatomical features of renal artery in a black Kenyan population: correlation with markers of atherosclerosis. *Anatomy Journal of Africa* 2016; 5: 650-660.
- [10] Madhusudhan KS, Venkatesh HA, Gamana-gatti S, Garg P and Srivastava DN. Interventional radiology in the management of visceral artery pseudoaneurysms: a review of techniques and embolic materials. *Korean J Radiol* 2016; 17: 351-63.
- [11] Katsumori T, Arima H, Asai S, Hayashi N and Miura H. Comparison of pain within 24 h after uterine artery embolization with Tris-Acryl gelatin microspheres versus gelatin sponge particles for leiomyoma. *Cardiovasc Intervent Radiol* 2017; 40: 1687-1693.
- [12] Zhang X, Zhao W, Huang J, Jiang Y and Shi Y. Clinical application value of interventional embolization in treating renal pseudoaneurysms. *J Interv Radiol* 2015; 379-382.
- [13] Hendricks NJ. Embolization therapy: principles and clinical applications. *J Vasc Interv Radiol* 2015; 26: 1076.
- [14] Reißberg S and Hartmann M. Principles of interventional treatment in epistaxis. *HNO* 2019; 67: 360-365.
- [15] Taniai N, Yoshida H and Uchida E. Interventional radiology: partial splenic embolization. Clinical investigation of portal hypertension. Springer; 2019. pp. 417-427.
- [16] Tang J, Haiping L, Chen C, Chen B and Ping H. DSA manifestations and interventional treatment of renal artery with severe hemorrhage following PCNL. *Endoscopy* 2017; 23: 99-102.
- [17] Ali T and Winterbottom A. Interventional urology. *Eur Urol* 2017; 171.
- [18] Mukund A, Kumar Dp V, Condati NK, Bhadoria AS and Sarin SK. Efficacy and safety of ultrasound guided percutaneous glue embolization in iatrogenic haemorrhagic complications of paracentesis and thoracocentesis in cirrhotic patients. *Br J Radiol* 2018; 91: 20170259.
- [19] Ierardi AM, Urbano J, Duka E, Lucchina N and Carrafiello G. Interventional radiology in the treatment of complications after digestive and biliopancreatic endoscopy. Imaging complications of gastrointestinal and biliopancreatic endoscopy procedures. Springer; 2016. pp. 165-178.
- [20] Tsetis DK, Perdikakis E and Kehagias E. Percutaneous treatment of iatrogenic femoral artery access complications. *Hell J Radiol* 2017; 2.
- [21] Dubey G and Chitkara K. Risk management of femoral arterial access-related complications in percutaneous coronary intervention. *Complications of Percutaneous Coronary Intervention*. Springer; 2016. pp. 261-275.