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Transarterial Embolization for Hematuria after Percutaneous Nephrolithotomy (PCNL)

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Abstract
Introduction: *Arterial embolization is an effective definitive therapy for treating severe bleeding after percutaneous nephrolithotomy (PCNL), especially when caused by vascular lesions such as pseudoaneurysms. Although rare, this complication can lead to massive hematuria and hemodynamic instability if not promptly treated.* ***Methods:*** *This is a descriptive case report of four patients experiencing post-PCNL bleeding. All patients underwent angiography and selective arterial embolization procedures appropriate to the vascular lesions identified.* ***Results and Discussion:*** *All four patients demonstrated significant clinical improvement after embolization. Angiography demonstrated successful occlusion of the bleeding source, and after approximately four days of observation, the patients clinically experienced no bloody urination and no post-procedure complications.* ***Conclusion:*** *Selective arterial embolization is an effective and safe treatment for massive post-PCNL bleeding due to vascular lesions such as pseudoaneurysms. The success of the procedure depends heavily on early detection, access to angiography facilities, and operator skill. Embolization should be a primary consideration in the management of severe hematuria after PCNL prior to performing invasive procedures.*

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Introduction

Embolization is a minimally invasive procedure for controlling bleeding that is less disruptive to surrounding tissue than surgery. Embolization can be performed to stop bleeding in cases of trauma, epistaxis, hemoptysis, gastrointestinal bleeding, post-surgical bleeding, or postpartum hemorrhage. It can also be used for vascular malformations and aneurysms, such as arteriovenous malformations (AVMs) and cerebral aneurysms. Embolization can be used to prevent tumor growth, such as in chemoembolization, uterine fibroid embolization, prostatic artery embolization, and hemorrhoids. This procedure can be performed quickly and promptly, making it preferable to open surgery(Lopera, 2010), (Lerardi et al., 2020).

In renal cases, embolization can be used for various renal pathologies and renal injuries, both electively and emergency. The most common cases are renal trauma, percutaneous nephrolithotomy (PCNL), and renal angiomyolipoma (AML). Indications for renal embolization are classified into three categories: iatrogenic (53%), post-traumatic, and tumor. Iatrogenic complications include post-PCNL (70%) with fluoroscopy, percutaneous nephrostomy, ultrasound-guided (USG) biopsy, and open renal surgery. Renal tumors include AML and renal cell carcinoma (RCC). According to Farg et al., most renal cases occur in the left kidney (Farg et al., 2023). Post-PCNL hemorrhage is one of the most clinically significant complications of the procedure, arising from inadvertent injury to intrarenal vessels during nephrostomy tract creation, which can lead to arteriovenous fistulas, pseudoaneurysms, or direct arterial bleeding. These vascular lesions may present as delayed or persistent hematuria requiring intervention beyond conservative management. Selective renal artery embolization is the preferred approach in this setting, as it targets the culprit vessel while preserving surrounding nephrons and maintaining overall renal function. Embolization should be performed with high selectivity to minimize renal infarction; microvascular plugs and removable coils are favored over liquid embolic agents due to their precision and ease of dosing. In cases involving pseudoaneurysms, aneurysm sac filling techniques using coils can effectively isolate the lesion from the circulation (Ierardi AM, et al, 2020). This case report aims to describe the clinical presentation, vascular findings, and outcomes of selective renal artery embolization in the management of post-PCNL hemorrhage.

Method

Embolization techniques involve access through the common femoral artery. Some techniques involve the left brachial artery. 2 Angioembolization has a success rate of 90 to 100%, depending on factors such as the availability and choice of equipment, and the staff performing the procedure. If re-embolization is necessary, the success rate reaches 92.3%.

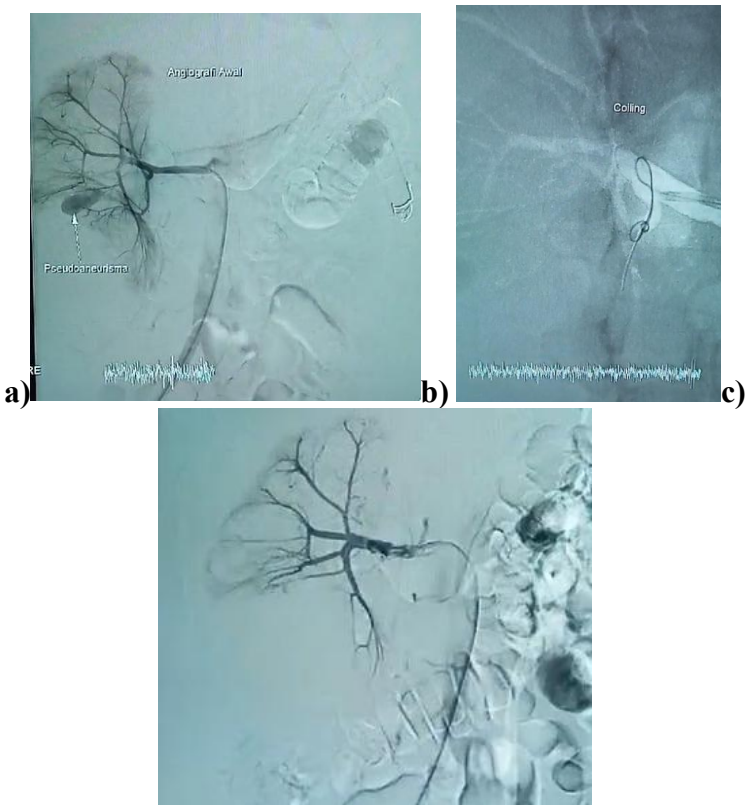
Result and Discussion

Case 1

In the first case, the patient presented with complaints of bloody urine since 13 days prior to admission. In addition to these complaints, the patient also experienced pain at the surgical site, low back pain, fever, and nausea. The patient had a history of a 4cm kidney stone, which underwent percutaneous nephrolithotomy (PCNL). Following the procedure, the patient's urine was mixed with blood and clots. In addition to PCNL, the patient underwent clot evacuation on September 21, 2024. Physical examination revealed anemic conjunctiva, tenderness to the right costovertebral angle, and a post-operative

wound on the right side with blood seepage through the gauze. The post-operative wound was well-cared for.

Laboratory tests revealed anemia and hypoalbuminemia. The initial diagnosis was hematuria due to a periapical renal laceration, post-right PCNL, a right staghorn kidney stone, and anemia. The patient was scheduled for transarterial embolization. The patient underwent puncture of the right common femoral artery and cannulation of the right renal artery. Initial angiography revealed a pseudoaneurysm branching from the inferior segmental artery. Embolization was performed with a 5mm coil on the branch of the artery affected by the pseudoaneurysm. Repeat angiography revealed no pseudoaneurysm in the right kidney. Following the procedure, hematuria was no longer visible on angiography, and clinically, bloody urine decreased (Figure 1). By day 3, there was no blood in the urine.



a) **b)** **c)**

Figure 1. Angiography of the first case a) Initial angiography, b) Coiling c) Post-operative angiography

Case 2

In the second case, the patient consulted a urologist with post-PCNL bloody urination. The complaint had been present for 17 days, and a urinary catheter had been inserted for the previous week uet o a blood clot and difficulty urinating. Physical examination revealed No. abnormalities. Blood tests revealed anemia, leukocytosis, hyponatremia, hypoalbuminemia, and slightly elevated urea (64 mg/dL) and creatinine (2.4 mg/dL). The initial diagnosis was post-PCNL hematuria with AFF DJ stenting uet o a left staghorn stone with hyponatremia, anemia, and hypoalbuminemia. The patient underwent transarterial embolization. Initial angiography revealed extravasation from the interlobar arteries originating from the inferior segmental artery and the anterior inferior

segmental artery. Embolization of the arteries was performed with a PVA count of 355-500. Post-embolization, No. extravasation was observed (Figure 2). On the fourth day after transatrial embolization, clinically, the urine was No. longer bloody.

a) b)

Figure 2. Angiography of the second case, a) Area to be embolized b) Post-procedure

Case 3

In the third case, the patient presented with complaints of bloody urine for three weeks, which had worsened since the day before. The patient had a history of right PCNL with DJ stent insertion. He was also an active smoker. Physical examination revealed anemic conjunctiva, tenderness to the right CVA, positive right ballottement, bulging, suprapubic tenderness, and a well-cared-for surgical wound. Blood tests revealed severe anemia, leukocytosis, and elevated urea (80 mg/dL) and creatinine (2.0 mg/dL). The patient was diagnosed with post-PCNL hematuria with CKD grade II-III. Transarterial embolization was recommended. A common femoral artery puncture was performed. Initial angiography revealed a pseudoaneurysm with turbulent flow in the media pole, so cannulation of the pseudoaneurysm area was performed and embolization was performed using a coil. No turbulence was observed on post-procedure angiography (Figure 3). Blood was still present in the urine on the first to third day of follow-up. On the 4th day, there was no longer any blood visible in the urine (Figure 4).

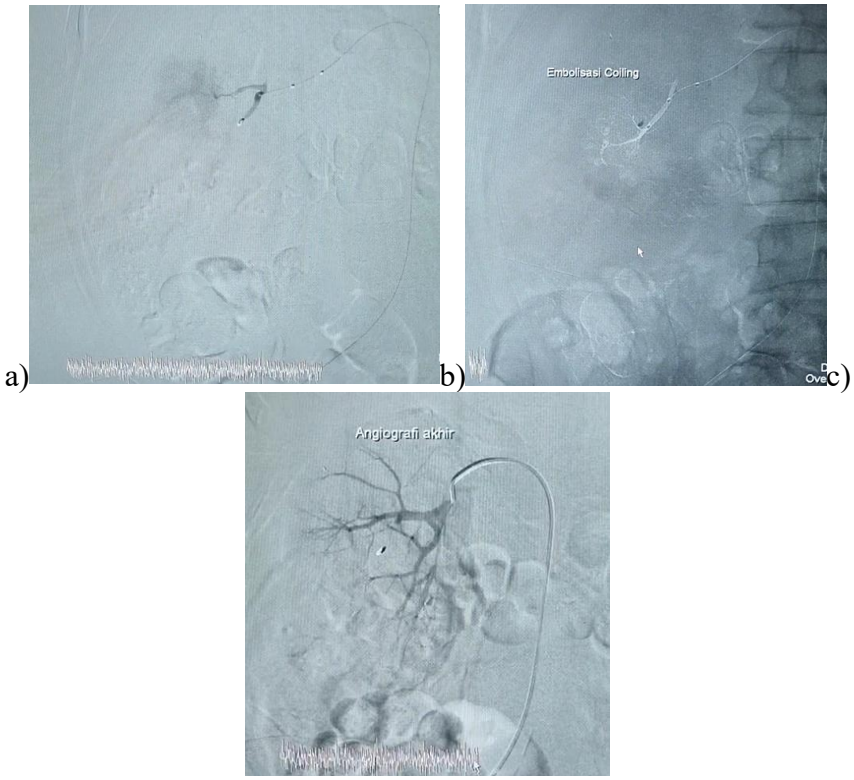


Figure 3. Angiography of the third case, a) Initial, b) Embolization c) Post-angiography

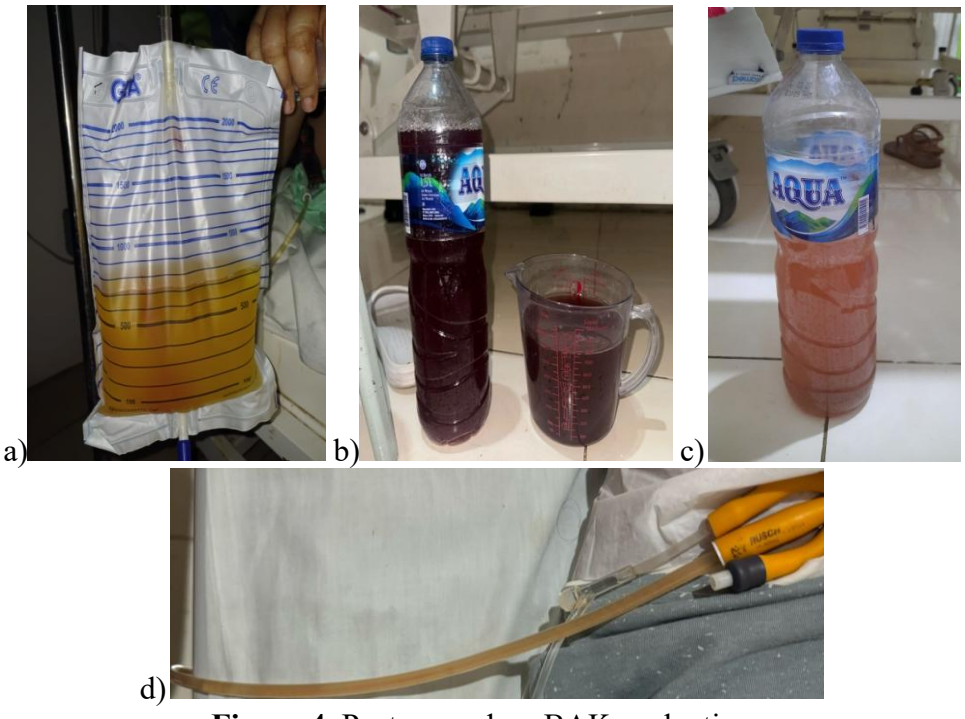


Figure 4. Post-procedure BAK evaluation

Percutaneous nephrolithotomy (PCNL) is the procedure of choice for treating kidney stones larger than 2 cm. Although this procedure is minimally invasive compared to conventional surgery, several complications can occur, such as bleeding. 6-8 Bleeding can occur due to needle puncture, dilation of the percutaneous tract, excessive torsion of the renal parenchyma, aggressive manipulation and extraction of the kidney stone, collateral damage to surrounding organs and blood vessels, or during removal of the nephrostomy tube. 9-11 The incidence of bleeding due to PCNL is approximately 0-20%, with 7% or even 11% requiring transfusion. Three significant factors indicating post-PCNL bleeding are an increase in serum creatinine of more than 1.5 mg/dL compared to preoperative levels, upper pole access, and tract enlargement. According to Zehri et al., elevated creatinine levels inhibit efficient platelet function and alter the interaction between the endothelium and platelets. However, research on serum creatinine remains controversial, as studies such as Aarora et al. found no significant results. Puncture of the renal calyceal papilla in the lower posterior calyx is the safest site. Furthermore, to avoid blood vessel rupture, the nephrostomy tract should only be dilated to the edge of the renal collecting system (dilation beyond the 11th or 12th rib carries a greater risk of injury). The use of a flexible nephroscope and smaller access points can minimize the risk of injury. In addition, the complexity of the stone (staghorn), multiple punctures, and operator skill are factors that can cause bleeding after PCNL. Massive bleeding can cause macroscopic hematuria. Intraoperatively, external pressure or cautery can be applied to the leaking vessel. If bleeding occurs after PCNL, the nephrostomy tract can be clamped for 3-7 hours and hemostatic agents administered (Monroy et al., 2025); (Surag KR, Shah A, Gali KV, Krishnakanth AVB, Chawla A, Hegde P, Choudhary A, 2024); (Arora, Pawar, Tamhankar, Sawant, & Mundhe, 2019); (Ahmad A, Gaurav, Mishra KG, 2019);

Signs of complications from macroscopic hematuria after PCNL include flank pain, nausea, vomiting, dizziness, and fever. This hematuria is caused by vascular lesions that form pseudoaneurysms (PAs), arteriovenous fistulas (AVFs), arteriocalyceal fistulas (ACFs), and arterioperirenal fistulas (APFs). Arteriovenous fistulas and pseudoaneurysms are the most common findings in these cases. AVFs and renal artery PAs are formed by high-pressure leakage from a ruptured artery, which is transmitted through the conduit into a system with less resistance, such as veins or connective tissue spaces. In PAs, damage occurs in the lumen of the renal artery and has imaging characteristics similar to an aneurysm. In AVFs, damage occurs in a combination of arteries and veins. In ACFs, injury occurs to the arteries in the calyces. In APFs, injury occurs to the arteries connected to the renal capsule. Blood then flows into the renal duct, and hematuria can occur (Adami et al., 2020); (Monroy et al., 2025); (Ahmad A, Gaurav, Mishra KG, 2019); (adayon N, Rafaei M, Zarrintan S, Shahsavari S, Najari D, 2024); (Irani et al., 2023);

Bleeding can occur immediately or be delayed (1-3 weeks), typically appearing several days after the procedure. Delayed hematuria is more common in patients with a history of diabetes, high blood pressure, or renal anomalies. To determine the cause of macroscopic hematuria in such cases, a CT angiography examination is performed. In cases of severe hematuria, patients can become hemodynamically unstable and experience heart failure. Transcatheter arterial embolization (TAE) is recommended for severe hematuria. However, if this technique fails, open vascular repair and, ultimately, nephrectomy can be performed (Adami et al., 2020); (Monroy et al., 2025); (Ahmad A, Gaurav, Mishra KG, 2019); (adayon N, Rafaei M, Zarrintan S, Shahsavari S, Najari D, 2024); (Irani et al., 2023);

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In the three cases presented, all patients developed delayed post-PCNL hematuria with distinct vascular lesion types on CT angiography—pseudoaneurysm, AVF, and ACF—reflecting the varied mechanisms of intrarenal vessel injury. In the pseudoaneurysm case, superselective coil embolization achieved complete sac exclusion, consistent with Tadayon et al. who reported resolution in all seven treated patients (adayon N, Rafaei M, Zarrintan S, Shahsavari S, Najari D, 2024). In the AVF case, a combined coil and particle approach was required to occlude the high-flow fistulous connection, aligned with Dong et al. who reported 23.9% of cases requiring combined PVA and coils (Dong, et al., 2020). In the ACF case, proximity to the collecting system demanded particular precision to avoid coil migration, as documented by Gokalp et al. in a rare case of coil prolapse into the proximal ureter. All three cases achieved technical success with hematuria resolution and hemodynamic stabilization without nephrectomy, confirming that individualized superselective embolization guided by lesion morphology and vascular anatomy is safe and effective for post-PCNL hemorrhage (Aravind S, et al., 2025); (Chelsea and Westminster Hospital., 2025).

Conclusion

Post-PCNL hemorrhage is a serious complication that can be caused by vascular injury, such as a pseudoaneurysm. Prompt identification through angiographic imaging is crucial to determine the source of bleeding. Selective arterial embolization using coils has been shown to be effective in stopping bleeding and addressing persistent hematuria. This procedure is a minimally invasive therapy with a high success rate and can avoid the risks of open surgery or nephrectomy. Therefore, embolization is the primary treatment option for severe post-PCNL bleeding, especially in hemodynamically stable patients. Adequate facilities and trained medical personnel are crucial factors in the success of this intervention.

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