



Original Article

Renal functional outcomes are not adversely affected by selective angioembolization following percutaneous nephrolithotomy



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Abstract *Objective:* Selective angioembolization (SAE) effectively diagnoses and treats iatrogenic vascular complications following percutaneous nephrolithotomy (PCNL).

Methods: We retrospectively reviewed 1329 consecutive PCNLs and identified patients who underwent SAE following PCNL with at least 12-month follow-up. Estimated glomerular filtration rate (eGFR) was calculated for all patients preoperatively, postoperatively and at last follow-up. A 1:2 matched cohort analysis was performed.

Results: Twenty-three patients underwent SAE and matched to 46 controls. There was no statistically significant difference in preoperative, postoperative, and follow-up eGFR when comparing patients who underwent SAE and those with an uneventful course.

Conclusion: Long-term eGFR is comparable in patients who undergo uncomplicated PCNL and those requiring SAE.

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1. Introduction

Percutaneous nephrolithotomy (PCNL) was first described by Fernstrom and Johansson [1] in 1976 and is now the preferred approach for the management of large, complex

renal stones. Despite its routine use in stone centers across the world, and the less invasive approach when compared to anotrophic nephrolithotomy, there remains a significant overall complication rate approaching 20% in contemporary cohorts [2,3]. Iatrogenic vascular injuries resulting in

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hemorrhage remain a serious complication with approximately 1%–11% of patients requiring transfusion of blood products [4–7]. While the majority of patients respond to conservative measures and recover without incident, 0.48%–2.6% will require selective angioembolization (SAE) for persistent hemorrhage or hemodynamic instability [8]. Although SAE is an effective procedure to control hemorrhage, embolization of a renal arteriole creates areas of ischemia and subsequent loss of functional parenchyma. Various authors have published their experience with vascular complications and attempted to identify potential risk factors, however the literature regarding the long-term effects on renal function in patients who underwent PCNL and required SAE for postoperative hemorrhage is limited. Furthermore, the studies available have not directly compared patients who underwent SAE to those who had a PCNL and did not necessitate SAE. The aim of this study was to investigate the renal functional outcomes in patients who underwent PCNL and required SAE, in comparison to patients who had an uneventful course.

2. Methods

After obtaining approval from the Feinstein Institute for Medical Research Institutional Review Board, we retrospectively reviewed 1329 consecutive PCNLs performed between 2008 and 2015. Patient demographics including age, gender, weight, body mass index (BMI), comorbidities, and medication history were identified. Laboratory evaluation included basic metabolic panel (BMP), complete blood count (CBC), International Normalized Ratio (INR), urinalysis, and urine culture. Patients were excluded from analysis if they did not have a serum creatinine measured at least 12 months postoperatively. Intraoperative and postoperative details including estimated blood loss (EBL), operating room time, number of punctures, number of dilations, blood product transfusion, and postoperative laboratory studies (CBC, BMP) were collected. All patients had cross sectional imaging available and images were reviewed to evaluate stone burden. Those patients who underwent SAE for postoperative hemorrhage were identified from our PCNL database. The indications for SAE included clinical signs of hemorrhagic shock, and failure to respond to conservative management (clamping nephrostomy tube, blood transfusion, intravenous fluid hydration, manual pressure, etc.). For those patients included in the final analysis estimated glomerular filtration rate (eGFR) was calculated using the Cockcroft-Gault equation.

A 1:2 matched cohort analysis was performed between patients who underwent SAE for post PCNL hemorrhage and those with an uncomplicated postoperative course, adjusting for age, hypertension, and diabetes mellitus. Using SPSS® v23.0 (IBM Corporation, Armonk, New York, USA), a comparison between the two groups was performed using Chi-square test for categorical variables and Student's t-test for continuous variables. A $p < 0.05$ was used to determine statistical significance.

All SAEs were performed by interventional radiology at our institution. Direct puncture into the femoral artery was achieved under ultrasound guidance and a 5 Fr vascular sheath was advanced under fluoroscopic guidance to the

abdominal aorta. A microcatheter was then directed into the renal artery and digital subtraction imaging was performed. Next a 2.8 Fr Progreat® microcatheter (Terumo Medical Corporation, Somerset, New Jersey, USA) was directed into the injured vessel of interest. A microwire was then used to direct the microcatheter to the vessel of interest and detachable coils are deployed. Postembolization angiography was performed in all patients and all patients were observed at least 24 h post procedure.

3. Results

Twenty-three (1.7%) patients underwent SAE and were matched to 46 patients who had an uneventful postoperative course. There were no significant differences in demographic data, operating room time, number of punctures, and tract dilations (Tables 1 and 2). All included patients in the cohort were managed nonoperatively, and SAE was effective in controlling hemorrhage. The mean number of blood transfusions differed between the SAE group and the control group (3.3% vs. 0.1%, $p < 0.001$) as did the EBL (476 mL vs. 162 mL, $p < 0.001$) and hematocrit change from baseline to postoperation (−10% vs. −5.6%, $p < 0.001$). Patients who required postoperative SAE had a significantly longer length of stay in comparison to matched controls (9.4 days vs. 3.2 days, $p < 0.001$) (Table 2). The mean follow-up in the SAE group and the matched cohort was 25 months and 18 months, respectively (Table 1). There was no statistically significant difference in eGFR between the SAE group and the matched control group in regards to preoperative eGFR (86.1 vs. 96.1 mL/min/1.73 m², $p = 0.432$), postoperative eGFR (85.5 vs. 96.4 mL/min/1.73 m², $p = 0.424$), follow-up eGFR (88.2 vs. 97.6 mL/min/1.73 m², $p = 0.423$), and change in eGFR between preoperative and follow-up period (2.1 vs. 1.9 mL/min/1.73 m², $p = 0.983$) (Table 3).

4. Discussion

Vascular complications following PCNL remain a worrisome complication, but most cases can be managed conservatively. Vascular injuries are the result of renal artery branch laceration, which can occur during initial needle passage for access or tract dilation. In the postoperative period, patients can present with immediate clinical signs of hemorrhage including hemodynamic instability (hypotension, shock, tachycardia), anemia, flank pain, and hematuria. Furthermore, patients can present in a delayed fashion (>3 days postoperatively), with new onset gross hematuria and aforementioned signs of hemorrhage. For these patients who continue to show signs of hemorrhage refractory to conservative measures, SAE is an effective minimally invasive approach to subside post-PCNL hemorrhage. The benefits of SAE are well established as it is effective in treating post-PCNL hemorrhage in up to 88%–100% of patients with minimal complications secondary to embolization [5,8,9]. However, SAE effectively embolizes renal artery branches and thus creates areas of ischemia in renal parenchyma. Furthermore, the detrimental effects of contrast-induced nephropathy must be considered as well. With the use of modern SAE techniques the area of

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