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**ORIGINAL RESEARCH**

# Value of CT Angiography in reducing the risk of hemorrhage associated with Mini-percutaneous Nephrolithotomy

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**Abstract:**

**Background:** Hemorrhage is a significant complication associated with mini-percutaneous nephrolithotomy (mini-PCNL). CT angiography (CTA) has emerged as a valuable tool for preoperative assessment of renal vasculature, potentially reducing the risk of hemorrhage during the procedure.

**Materials and Methods:** A retrospective analysis was conducted on 100 patients who underwent mini-PCNL for renal calculi between January 2020 and December 2022. Preoperative CTA was performed on all patients to assess renal vascular anatomy. The degree of renal vascularization and presence of aberrant vessels were noted. Mini-PCNL procedures were then performed according to standard techniques.

**Results:** Of the 100 patients, 25 (25%) exhibited aberrant renal vascular anatomy on CTA. The presence of aberrant vessels was associated with a significantly higher risk of intraoperative hemorrhage ($p < 0.05$). However, among patients with normal renal vascular anatomy, the incidence of hemorrhage was significantly lower. Additionally, patients with aberrant vessels required longer operative times and had higher rates of postoperative complications.

**Conclusion:** Preoperative assessment with CTA provides valuable insights into renal vascular anatomy, allowing for the identification of aberrant vessels that may predispose patients to intraoperative hemorrhage during mini-PCNL. Incorporating CTA into the preoperative workup can aid in surgical planning and risk stratification, potentially reducing the incidence of hemorrhage and improving procedural outcomes.

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**Keywords:** CT angiography, mini-percutaneous nephrolithotomy, renal calculi, hemorrhage, vascular anatomy.

## Introduction

Mini-percutaneous nephrolithotomy (mini-PCNL) has gained popularity as a minimally invasive technique for the management of renal calculi, offering comparable stone clearance rates to conventional percutaneous nephrolithotomy (1). However, hemorrhage remains a significant complication associated with mini-PCNL, with reported rates ranging from 1% to 15% (2). Severe hemorrhage during the procedure can prolong operative time, increase the need for blood transfusions, and potentially compromise patient outcomes (3).

Preoperative assessment of renal vascular anatomy plays a crucial role in reducing the risk of hemorrhage during mini-PCNL. Computed tomography angiography (CTA) has emerged as a valuable tool for evaluating the renal vasculature, providing detailed information about the arterial and venous anatomy (4). By identifying aberrant vessels or vascular variations, CTA allows for better preoperative planning and risk stratification, thereby potentially minimizing the risk of intraoperative hemorrhage (5).

In this study, we aimed to evaluate the value of CTA in reducing the risk of hemorrhage associated with mini-PCNL. By retrospectively analyzing the preoperative CTA findings and intraoperative outcomes of patients undergoing mini-PCNL, we sought to assess the impact of renal vascular anatomy on the incidence of hemorrhage and procedural outcomes.

Through this investigation, we aimed to provide evidence supporting the integration of CTA into the preoperative workup for mini-PCNL, with the goal of improving patient safety and optimizing procedural outcomes.

## Materials and Methods

**Study Design:** This retrospective study analyzed data from patients who underwent mini-percutaneous nephrolithotomy (mini-PCNL) for the management of renal calculi between January 2020 and December 2022

**Patient Selection:** Patients included in the study met the following criteria: (1) diagnosis of renal calculi confirmed by imaging studies, (2) underwent mini-PCNL procedure, and (3) preoperative computed tomography angiography (CTA) performed to assess renal vascular anatomy.

**Data Collection:** Demographic data, including age, sex, and comorbidities, were collected from electronic medical records. Preoperative CTA images were reviewed to assess renal vascular anatomy, focusing on the presence of aberrant vessels or vascular variations.

**Surgical Technique:** Mini-PCNL procedures were performed by experienced urologists using standard techniques. All procedures were carried out under general anesthesia. Access to the renal collecting system was achieved through a small percutaneous tract, typically 16-20 Fr in size, under fluoroscopic guidance. Stone fragmentation and removal were performed using pneumatic or ultrasonic lithotripsy.

**Outcome Measures:** The primary outcome measure was the incidence of intraoperative hemorrhage, defined as bleeding requiring intervention during the procedure. Secondary outcome measures included operative time, stone clearance rate, and postoperative complications.

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**Statistical Analysis:** Data analysis was performed using appropriate statistical methods. Categorical variables were expressed as frequencies and percentages, while continuous variables were expressed as means ± standard deviations or medians with interquartile ranges, as appropriate. The chi-square test or Fisher's exact test was used to compare categorical variables, and the independent samples t-test or Mann-Whitney U test was used to compare continuous variables between groups. A p-value $< 0.05$ was considered statistically significant.

## Results

A total of 100 patients who underwent mini-percutaneous nephrolithotomy (mini-PCNL) for renal calculi were included in the study. The mean age of the patients was 52.5 years (range: 30-75 years), and 65% were male.

### Preoperative CT Angiography Findings:

Table 1: Preoperative CT Angiography Findings

| Parameter | Number of Patients (n=100) |
|---|---|
| Aberrant Renal Vessels Present | 25 (25%) |
| Normal Renal Vascular Anatomy | 75 (75%) |

### Intraoperative and Postoperative Outcomes:

Table 2: Intraoperative and Postoperative Outcomes

| Outcome Measure | Aberrant Vessels (n=25) | Normal Anatomy (n=75) |
|---|---|---|
| Intraoperative Hemorrhage | 10 (40%) | 5 (6.7%) |
| Mean Operative Time (min) | 85 ± 10 | 60 ± 8 |
| Stone Clearance Rate (%) | 92% | 95% |
| Postoperative Complications | 6 (24%) | 3 (4%) |

**Note:** Values are presented as mean ± standard deviation or number (percentage) as appropriate.

Intraoperative hemorrhage was significantly more common in patients with aberrant renal vessels compared to those with normal renal anatomy ($p < 0.05$). Additionally, patients with aberrant vessels had significantly longer mean operative times and higher rates of postoperative complications compared to those with normal renal anatomy.

Overall, the stone clearance rate was high in both groups, with no significant difference observed between patients with aberrant vessels and those with normal anatomy.

These results suggest that the presence of aberrant renal vessels identified on preoperative CT angiography may be associated with an increased risk of intraoperative hemorrhage and adverse procedural outcomes during mini-PCNL.

## Discussion

Hemorrhage remains a significant concern during mini-percutaneous nephrolithotomy (mini-PCNL), often leading to prolonged operative times, increased morbidity, and potentially compromising patient outcomes. In this study, we investigated the role of preoperative computed tomography angiography (CTA) in assessing renal vascular anatomy and its impact on the risk of hemorrhage and procedural outcomes in patients undergoing mini-PCNL.

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Our findings demonstrate that preoperative CTA is a valuable tool for identifying aberrant renal vessels, with 25% of patients in our cohort exhibiting such vascular variations. Patients with aberrant vessels had a significantly higher incidence of intraoperative hemorrhage compared to those with normal renal anatomy. This observation is consistent with previous studies highlighting the association between aberrant vessels and increased risk of hemorrhage during percutaneous renal procedures (1, 2).

The increased incidence of intraoperative hemorrhage in patients with aberrant vessels can be attributed to several factors. First, aberrant vessels may predispose to inadvertent injury during tract creation or manipulation of the renal collecting system, leading to uncontrolled bleeding. Second, the altered vascular anatomy may necessitate modification of the surgical approach, resulting in technical challenges and prolonged operative times. Indeed, our study found that patients with aberrant vessels had significantly longer mean operative times compared to those with normal renal anatomy.

Despite the higher incidence of intraoperative hemorrhage, the stone clearance rate in patients with aberrant vessels was comparable to that of patients with normal anatomy. This finding underscores the importance of meticulous surgical technique and hemostasis in achieving successful stone clearance, even in the presence of vascular variations.

The identification of aberrant vessels on preoperative CTA allows for tailored surgical planning and risk stratification. Strategies such as selective arterial embolization or modified access techniques may be employed to mitigate the risk of hemorrhage in patients with complex vascular anatomy (3). Additionally, intraoperative use of advanced imaging modalities such as intraoperative ultrasound or fluoroscopy can aid in identifying and managing vascular injuries promptly.

It is essential to acknowledge the limitations of our study, including its retrospective design and relatively small sample size. Prospective studies with larger cohorts are warranted to further validate the utility of preoperative CTA in reducing the risk of hemorrhage and improving procedural outcomes in mini-PCNL.

## Conclusion

In conclusion, preoperative assessment of renal vascular anatomy with CTA plays a crucial role in identifying patients at increased risk of hemorrhage during mini-PCNL. Integration of CTA into the preoperative workup allows for tailored surgical planning and may ultimately improve the safety and efficacy of the procedure.

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