Original Article

10-year Surgical Outcomes of Percutaneous Nephrolithotomy, A Single-Center Retrospective Study from Thailand

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Received: February 24, 2025
Revision received: August 11, 2025
Accepted after revision: October 1, 2025
BKK Med J 2026;22(1): 1-5.
DOI: 10.31524/bkkmedj.2026.11.001
www.bangkokmedjournal.com

Abstract

OBJECTIVES: Percutaneous nephrolithotomy (PCNL) is an effective procedure for treating renal stones, particularly when the stone size is a staghorn stone or larger than 20 millimeters, or when it is between 10 and 20 millimeters in size and located in the lower calyx. Previous studies of PCNL have shown high stone-free rates (SFR) with minimal complications. Although previous studies have examined SFRs following PCNL in Thailand, the objective of this research is to expand the national database on PCNL outcomes. This study aims to evaluate the outcomes, including the efficacy and safety, of PCNL performed at Vajira Hospital.

MATERIALS AND METHODS: We conducted a single-center, retrospective descriptive study that enrolled patients who underwent PCNL at Vajira Hospital, Thailand, between January 2012 and December 2022. SFR was defined as a residual stone size of less than 4 millimeters on imaging. Perioperative bleeding and postoperative urinary tract infections (UTIs) were recorded.

RESULTS: A total of 203 patients underwent PCNL. Among these, the types of stones were staghorn (n = 96, 47.3%), small non-staghorn stones sized between 10-20 millimeters (n = 23, 11.3%), and large non-staghorn stones larger than 20 millimeters (n = 84, 41.4%). The median preoperative glomerular filtration rate (GFR) was 84 mL/min/1.73 m² (range: 5-132). Preoperative UTI was present in 38.4% (n=78) of patients. SFR was 43.3%. Patients with non-staghorn stones had a significantly higher SFR compared to those with staghorn stones (56.1% vs. 29.2%, respectively, $p < 0.01$). There was no significant difference in SFR between the small and large non-staghorn stone groups ($p = 0.601$). Postoperative GFR were comparable between the stone-free group and the residual stone group. Postoperative UTI and bleeding were recorded at rates of 13.8% and 8.4%, respectively.

CONCLUSION: In this study, SFR following PCNL was 43.3%. Patients with non-staghorn stones exhibited a higher SFR compared to those with staghorn stones. Additionally, the postoperative complication rates were considered acceptable.

Keywords: renal stone, staghorn stone, PCNL, stone free rate, SFR

Numerous older retrospective studies have demonstrated that untreated patients with staghorn stones are at risk of renal function deterioration, including loss of the affected kidney, progression to end-stage renal disease, infectious complications, and mortality.[1-5] PCNL is an effective procedure for treating renal stones, particularly when the stone is a staghorn stone or larger than 20 millimeters, or when it is between 10 and 20 millimeters in size and located in the lower calyx. Previous studies on PCNL have reported high SFRs with minimal complications.

Wishahi, El Feel[6] conducted a study with 40 patients who had 2-4 cm kidney stones and were treated with standard PCNL. The study demonstrated an SFR of 85%. Additionally, the mean change in creatinine levels post-procedure was minimal, at 0.07 mg/dL, suggesting that the procedure had a relatively low impact on renal function in this patient group.

Xiao, Li[7] conducted a study involving 54 patients with staghorn calculi who underwent PCNL in China. The study reported an SFR of 64.8%, with a significant proportion of patients (20.4%) experiencing postoperative fever.

El-Nahas, Eraky[8] conducted a study involving 238 patients who underwent PCNL for staghorn stones between 1999 and 2009 in Egypt. The study found an SFR of 56.6% for PCNL monotherapy. Additionally, 16% of patients experienced bleeding complications that required blood transfusions.

Although there have been studies on SFRs following PCNL in Thailand, the objective of this research is to expand the national database regarding PCNL outcomes.[9-12] This study aims to assess the outcomes of PCNL at a single center, Vajira Hospital, focusing on both efficacy and safety. Establishing this data will be beneficial for future research and advancements in the field.

Materials and Methods

This single-center, retrospective descriptive study enrolled patients who underwent PCNL at Vajira Hospital, Thailand, between January 2012 and December 2022 , with patients and definitions described as follows.

Inclusion criteria:

- Patients aged ≥18 years who underwent PCNL at Vajira Hospital between January 2012 and December 2022.

Excluded criteria:

- Patients with incomplete or improperly recorded medical records.

Definitions:

- A **staghorn stone** was defined as a renal stone occupying the renal pelvis and extending into at least two calyces. **A non-staghorn stone** referred to any renal stone not meeting this criterion. Non-staghorn stones were further classified as **small** (10–20 mm) or **large** (>20 mm).
- The **stone-free rate** (SFR) was defined as the absence of renal stones or the presence of residual stones measuring ≤4 mm after surgery, as assessed by imaging studies, including plain kidney–ureter–bladder (KUB) radiographs or computed tomography (CT) scans.
- **Urinary tract infection** (UTI) was diagnosed based on an increased white blood cell count on urinalysis together with positive bacterial urine cultures.
- **Postoperative bleeding** was defined as blood leakage from the surgical wound or drainage tube, with drainage volumes exceeding ≥ 400 mL/hour for 1 hour, ≥ 200 mL/hour for 2 consecutive hours, or ≥ 100 mL/hour for 4 consecutive hours.

Outcomes

The primary outcome of this study was SFR at one month following PCNL. Secondary outcomes include changes in GFR after the procedure, the incidence of postoperative UTIs, and the rate of postoperative bleeding complications.

Statistical analysis

Statistical analysis was performed using SPSS version 23, with quantitative data, including age, preoperative GFR, and percent changes in GFR, presented as median and range. Qualitative data, such as gender, comorbidities, stone type and location, UTIs before and after surgery, and postoperative bleeding, were analyzed using frequency calculations and presented as percentages. Relationships between data were assessed using the chi-square test for categorical data and the Mann-Whitney U test for continuous data. A significance level of $p < 0.05$ was considered to determine statistical significance.

Results

A total of 203 patients underwent PCNL. The types of stones were staghorn stones (n = 96, 47.3%), small non-staghorn stones sized between 10-20 millimeters (n = 23, 11.3%), and large non-staghorn stones larger than 20 millimeters (n = 84, 41.4%). Stone locations included the lower pole of the kidney (n = 150, 73.9%), middle pole (n = 135, 66.5%), upper pole (n = 84, 41.4%), and renal pelvis (n = 31, 15.3%). The median preoperative GFR was 84 (range: 5-132), with minimal differences between staghorn and non-staghorn patients, without statistical significance. Preoperative UTI was present in 38.4% (n = 78) of patients. Other characteristics are shown in Table 1.

Table 1: Patient characteristics (n = 203).

Characteristics	n (%)
Age (years)	
Median age	52
Range age	20 - 80
Gender	
Male	104 (51.2)
Female	99 (48.8)
Underlying disease	
Diabetes mellitus	36 (17.7)
Hypertension	62 (30.5)
Chronic kidney disease	
Stage I-III	195 (96.1)
Stage IV	6 (3.0)
Stage V	2 (1.0)
Stone type	
Staghorn stone	96 (47.3)
Non-staghorn stone	107 (52.7)
Small size	23 (11.3)
Large size	84 (41.4)
Stone position	
Upper pole	84 (41.4)
Middle pole	135 (66.5)
Lower pole	150 (73.9)
Renal pelvis	31 (15.3)
Preoperative urinary tract infections	78 (38.4)
Median preoperative glomerular filtration rate (mL/min/1.73 m2) (range)	84 (5-132)
Staghorn stone	85 (5-130)
Non-staghorn stone	83 (14-132)

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Outcomes

SFR was 43.3% (n = 88). In a subgroup analysis, patients with non-staghorn stones had a significantly higher SFR compared to those with staghorn stones (56.1% vs. 29.2%, $p < 0.01$), as shown in Figure 1. There was no significant difference in the SFR between the small and large non-staghorn stone groups (60.9% vs. 54.8%, $p = 0.601$), as shown in Figure 2. Residual stones were more common in the lower pole compared to other locations, as shown in Figure 3. The median percent change in GFR was -4.6%. The rate of postoperative UTIs was 13.8% (n = 28), while the rate of postoperative bleeding was 8.4% (n = 17). In the subgroup analysis, there was a higher percent change in GFR and a higher rate of postoperative bleeding in the residual stone group, but there was no difference in postoperative UTI. However, these differences were not statistically significant, as shown in Table 2. When comparing the staghorn and non-staghorn groups, no statistically significant differences were found in postoperative UTI or postoperative bleeding, as shown in Table 3.

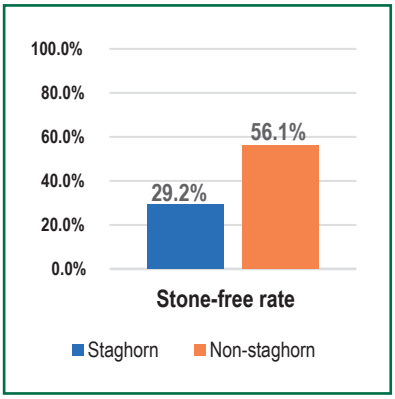


Figure 1: Stone-free rate in Staghorn vs Non-staghorn

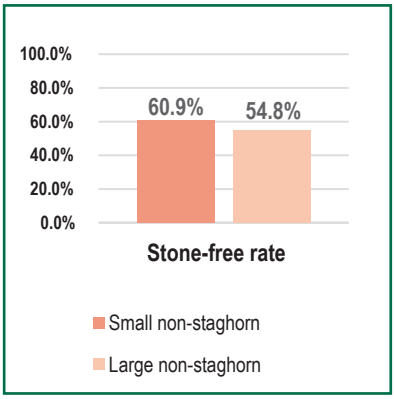


Figure 2: Stone-free rate in Small- vs Large- Non-staghorn

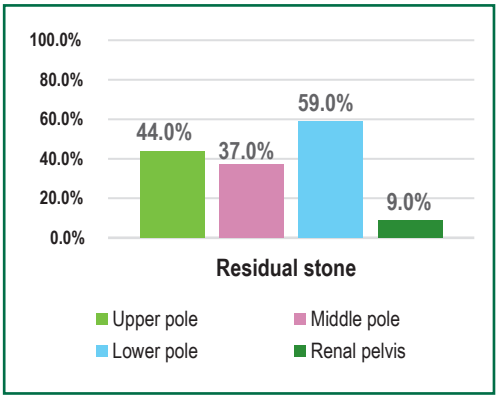


Figure 3: Positions of residual stone after PCNL

Table 2: Comparison in postoperative % change in GFR, UTI, and bleeding between stone-free and residual stone group.

	Stone-free group n (%)	Residual stone group n (%)	*p*-value
Median percent change in glomerular filtration rate (Range)	-3.4 (-46 to 166)	-5.6 (-66 to 200)	0.492
Postoperative urinary tract infections	12 (14.8)	16 (14.4)	0.938
Postoperative bleeding	5 (5.7)	12 (10.4)	0.235

Table 3: Comparison in postoperative UTI, and bleeding between staghorn and non-staghorn group.

	Stone-free group n (%)	Residual stone group n (%)	*p*-value
Postoperative urinary tract infections	14 (15.2)	14 (14)	0.811
Postoperative bleeding	10 (10.4)	7 (6.6)	0.330

Discussion

A large multicenter study involving 5,803 patients reported an SFR of 75.7%. Complications included significant bleeding in 7.8% of cases, with blood transfusions required in 5.7% of patients.[13] A large systematic review involving nearly 12,000 patients reported the incidence of infection and bleeding complications associated with PCNL as follows: fever (10.8%), transfusion (7%), sepsis (0.5%), and embolization (0.4%).[14] In comparison, the overall SFR one month following PCNL in this study was 43.3%, which is lower. Several factors may contribute to this lower success rate, including a short follow-up period, as some studies demonstrate improved SFR at three months.[6-8] The complexity of the stones, assessed using Guy's Stone Score, a reliable tool for predicting SFR[15,16], resulted in nearly 50% of patients having a high-grade (grade 3-4) Guy's score in this study–complete staghorn (grade 4) 35%, partial staghorn (grade 3) 12.3%—which may have contributed to the lower SFR. Variations in the single-tract technique (upper vs. non-upper pole access) have also been shown to affect the SFR in some studies.[17] Additionally, the anatomy of the pelvicalyceal system, particularly the surface area, impacts the SFR. A smaller surface area of the pelvicalyceal system may result in a decrease in the SFR.[18] The use of rigid nephroscopy alone

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may have contributed to the low SFR, as several studies have demonstrated that combining rigid and flexible nephroscopy can increase SFR.[19]

In the subgroup analysis, SFR was higher in the non-staghorn stone group, with statistical significance. This was associated with lower stone complexity, consistent with findings from other studies.[20] The median percent change in GFR from pre- to post-operation decreased by 4.6%, which is considered an acceptable result. The postoperative complication rates, including UTIs (13.8%) and bleeding (8.4%), were comparable to those reported in the literature[14], supporting the safety of the procedure. This center administers antibiotic prophylaxis as a single dose within 60 minutes before the procedure, or a 3-day course for patients presenting with preoperative UTI. In the future, the rate of UTI may be further reduced by extending the duration of antibiotic prophylaxis, such as using a 1-week course of antibiotics before the procedure, even in patients with sterile urine, as suggested by some study data.[21,22]

The study was limited by a small sample size. Approximately 300 patients were initially included, but incomplete or inaccurate medical records resulted in exclusions, leaving 203 patients. This reduction in sample size slightly diminishes the reliability of the study.

As this research did not fully address the factors that influence the outcomes, future studies will aim to identify and clarify the factors contributing to the lower SFR at this center and potentially resolve the issue. This will involve further development and refinement of the surgical technique, along with a subsequent comparison to improve outcomes and reduce postoperative complication rates.

Conclusion

In this study, SFR following PCNL was 43.3%. Patients with non-staghorn stones had a higher SFR than those with staghorn stones. Additionally, the postoperative complication rates were deemed acceptable, suggesting that the procedure was generally safe and effective for the population studied.

Conflict of Interest

The authors declare no conflict of interest.

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