Health Affair, ISSN - 0278-2715
Volume 12 ISSUE 12, pp.3563-3572
health-affair.com

EARLY POST-OPERATIVE COMPLICATIONS OF PERCUTANEOUS NEPHROLITHOTOMY (PCNL) IN TERTIARY CARE SETTING OF KHYBER PAKHTUNKHWA

Submission: 7/11/25
Acceptance: 5/12/25
Publication: 25/12/25

Submission: 07 November 2025 | Acceptance: 05 December 2025 | Publication: 25 December 2025

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ABSTRACT

Background: While percutaneous nephrolithotomy (PCNL) is the gold-standard intervention for large renal calculi, reported complication rates vary widely (20-83%). There is a scarcity of precise data on early postoperative outcomes following PCNL from tertiary care settings in the Khyber Pakhtunkhwa region.

Objective: This study aimed to ascertain the frequency of early postoperative complications in patients undergoing PCNL at a tertiary care hospital in Khyber Pakhtunkhwa.

Methods: We conducted this descriptive study in the Department of Urology, Ayub Teaching Hospital, Abbottabad, from 5th August, 2025. A cohort of ninety-seven patients scheduled for PCNL was recruited through consecutive non-probability sampling. Demographic, operative, and outcome data (including fever, hemorrhage, and stone clearance within one week) were gathered via a structured proforma and analyzed with SPSS version 27.0.

Results: The mean patient age was 35.51 ± 14.43 years, and a majority were male (52.6%). Complications occurred in 37.1% (n=36) of cases. The most common complication was postoperative fever (≥38°C), affecting 26.8% (n=26) of patients, followed by significant hematuria indicating hemorrhage (13.4%, n=13). A stone-free status was achieved in 45.4% (n=44) of procedures. Statistical analysis revealed no significant correlations between the incidence of complications and age, gender, BMI, stone size, or operative duration ($p > 0.05$).

Conclusion: The findings indicate a significant rate of early complications, chiefly fever and hemorrhage, post-PCNL. Importantly, standard patient and stone characteristics did not emerge as significant risk factors, highlighting the procedural consistency and safety of PCNL across varied demographics within a tertiary care context.

Keywords: Percutaneous nephrolithotomy, PCNL, postoperative complications, fever, hemorrhage, stone clearance, Khyber Pakhtunkhwa, tertiary care, urology

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Health Affair, ISSN - 0278-2715
Volume 12 ISSUE 12, pp.3563-3572
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INTRODUCTION

Goodwin and colleagues first described the percutaneous kidney technique in 1955[1]. This involved placing a nephrostomy tube, and the same access was later used as a utility channel for percutaneous kidney stone removal. This development marked the beginning of percutaneous stone surgery[2]. Before this, large renal stones were treated surgically by urologists using open techniques such as pyelolithotomy and nephrolithotomy, both of which had disadvantages. Morbidity and mortality related to renal stones decreased largely due to the widespread adoption of this new modality[3].

Percutaneous nephrolithotomy (PCNL) subsequently became the standard treatment for large-volume kidney stones, as well as for upper tract stones that could not be treated with other methods, lower pole stones that were difficult to remove, cystine stones, and stones in structurally abnormal kidneys. PCNL proved to be a safe and less invasive procedure, though, like any other surgery, it carried certain associated risks[4,5].

In published literature, the reported complication rates of PCNL ranged from 20% to 83%. Recent data on PCNL outcomes included only selected procedure-related risks, which made it difficult to establish and analyze the true incidence of complications. To improve reporting, some authors applied modified versions of the Clavien grading system or assigned scores to the commonly observed complications associated with PCNL[6,7].

Most minor complications observed were short-term fever (10–30%) and nephrostomy tube leakage (15%). The percutaneous entry into the renal collecting system was often associated with major complications (Clavien grade III, IV, and V), including bleeding, infection, visceral organ damage, and lung injury. Several studies reviewed strategies aimed at reducing complication rates and promptly managing these adverse events[6,8].

Up to 30% of patients experienced short-term fever in the early postoperative period following PCNL, but the incidence of sepsis was lower, ranging from 0% to 3% in patients who received proper perioperative antibiotic prophylaxis. Systemic inflammatory response syndrome (SIRS) represented a severe form of infection, and up to 30% of patients ultimately required intensive care treatment. Univariable analyses showed that postoperative fever was more frequent in female patients, those requiring more renal punctures, patients with staghorn stones, and those with positive urine cultures. On multivariable analysis, risk factors included stone size greater than 10 cm, positive urine or stone cultures, and multiple calyceal entries[9].

Data from intraoperative renal pelvis cultures, which could have guided antibiotic therapy, were not always available, and the pathogen spectrum often differed from preoperative urine cultures. Korets reported that 33% of patients with positive intraoperative renal pelvis cultures showed no pathogens on preoperatively collected urine samples[9].

Bleeding could occur at any stage of PCNL. Although massive hemorrhage from injury to major renal vessels was rare (<0.5%), perioperative blood transfusion was required in approximately 5.5% of cases, and 1% of patients experienced major bleeding. Most vessel injuries occurred during the initial percutaneous access[10]. The clinical indicators of massive perioperative hemorrhage requiring blood transfusion or other interventions were studied extensively. The risk of bleeding increased with the number of renal access tracts. A large retrospective series of 3,878 patients undergoing PCNL reported a transfusion rate of 5.5% and a 1% rate of major bleeding, with a median transfusion of three units (range 1–6)[11].

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Volume 12 ISSUE 12, pp.3563-3572
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MATERIALS AND METHODS

Study design

This was a descriptive study.

Setting

The study was conducted in the Department of Urology, Ayub Teaching Hospital, Abbottabad.

Duration of study

The duration of study was 3 months.

Sample size

The sample size was 97 patients. It was calculated using the formula for single population proportion:

$n = Z^2 \times p\ (1 - p) / d^2$

Where:

- n = required sample size
- Z = Z-score (1.96 for 95% confidence)
- p = estimated proportion of early postoperative complications of PCNL = 0.2012
- d = precision or margin of error (0.08 or 8%)

Sampling technique

Non-probability consecutive sampling was used.

Selection criteria

Inclusion criteria

- Patients older than 12 years and younger than 60 years
- Both male and female gender
- Normal renal function
- Average stone size > 2 cm
- Lower pole stones > 1 cm
- Patients who had failed ESWL

Exclusion criteria

- Patients with active urinary tract infection
- Patients with bleeding tendency
- Patients with lung disease
- Patients with cardiovascular disease
- Patients with high body mass index
- Patients with stones in multiple renal calyces
- Patients with thinned-out renal cortex

Data collection procedure

After ethical approval was obtained from the Institutional Ethical Review Board of Ayub Teaching Hospital, Abbottabad (Ref.No.RC-EA-2025/022) and the College of Physicians and Surgeons Pakistan (CPSP), patients who fulfilled the selection criteria were admitted from the urology outpatient department of Ayub Teaching Hospital, Abbottabad. Informed consent was obtained after the study's goals, benefits, and risks had been explained. A detailed medical history, physical examination, and laboratory investigations were performed, including complete blood count, biochemistry for renal function, coagulation profile, viral serology, urine analysis, and urine culture/sensitivity to rule out urinary tract infection.

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All patients underwent CT urography as part of their imaging, along with kidney, ureter, and bladder ultrasonography. Prophylactic antibiotics were given, and sterile urine cultures were ensured. The duration of surgery was recorded from induction of anesthesia, including patient positioning and the PCNL approach with placement of double-J stents.
Postoperatively, fever and hematuria were charted during the first week. Data were collected on a predesigned structured questionnaire (annexure).

Operational definitions

- *PCNL*: Minimally invasive surgical procedure defined as the removal of kidney stones through a percutaneous access tract created through the skin and into the kidney, using a nephroscope and various instruments, under fluoroscopic or ultrasonic guidance, with the aim of fragmenting and extracting stones, with or without nephrostomy tube placement.
- *Early complications*: Complications that developed within one week after surgery.
- *Hematuria*: ≥3 red blood cells per high-power field (RBC/HPF) in a urine sediment examination or ≥50 RBC/μL in a urine sample.
- *Fever*: Temperature ≥38 °C occurring 24–48 hours after PCNL surgery, sustained for at least two consecutive measurements four hours apart, not attributable to medications or environmental factors.
- *Complication rate*: The total number of patients who developed complications during or after surgery within 30 days of the procedure, expressed as a percentage of all patients undergoing PCNL.

Data analysis procedure

Data entry and analysis were performed using SPSS version 27.0. Mean ± standard deviation or median (IQR) was calculated for quantitative variables such as age, weight, height, BMI, stone size, site of stone, number of tracts, and duration of surgery after checking normality with the Shapiro–Wilk test. For categorical variables such as gender, education, profession, urinary leakage, blood transfusions, and fever, frequency and percentage were calculated.
Effect modifiers such as age, gender, and BMI were controlled through stratification. Post-stratification, the chi-square test or Fisher's exact test was applied. A p-value ≤0.05 was taken as statistically significant

RESULT

This study included 97 patients who underwent Percutaneous Nephrolithotomy (PCNL). Their demographic and clinical profiles are outlined in Table 1. The average age was 35.51 ± 14.43 years, with males slightly more represented (51 patients, 52.6%). The mean Body Mass Index (BMI) measured 27.44 ± 8.00 kg/m². Residence was nearly evenly split between rural (51.5%) and urban (48.5%) populations. The average stone size was 35.53 ± 9.04 mm, most often situated in the lower pole (26.8%), followed by the renal pelvis (25.8%), upper pole (24.7%), and multiple calyceal sites (22.7%). The mean operative duration was 29.53 ± 17.92 minutes, and the mean hospital stay was 6.07 ± 2.58 days.

Table 1: Demographic and Clinical Characteristics of Patients (N=97)

Variable	Value (Mean ± SD or n (%))
Age (years)	35.51 ± 14.43
Gender	
Male	51 (52.6%)

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Variable	Value (Mean ± SD or n (%))
Female	46 (47.4%)
BMI (kg/m²)	27.44 ± 8.00
Residence	
Rural	50 (51.5%)
Urban	47 (48.5%)
Stone Size (mm)	35.53 ± 9.04
Stone Site	
Lower pole	26 (26.8%)
Pelvis	25 (25.8%)
Upper pole	24 (24.7%)
Operative Time (minutes)	29.53 ± 17.92
Hospital Stay (days)	6.07 ± 2.58

The postoperative outcomes are summarized in Table 2. Among the 97 procedures, 36 (37.1%) were associated with at least one early complication. The predominant complication was fever (>38°C), which developed in 26 patients (26.8%). This was followed by hemorrhage, manifested as significant hematuria, in 13 cases (13.4%). Conversely, 61 patients (62.9%) recovered without any documented complications. The overall success rate, defined as complete stone clearance, was 45.4% (n=44).

Table 2: Postoperative Complications and Outcomes (N=97)

Outcome/Complication	Frequency (n (%))
Overall Complications	**36 (37.1%)**
Fever (>38°C)	26 (26.8%)
Hemorrhage	13 (13.4%)

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Volume 12 ISSUE 12, pp.3563-3572
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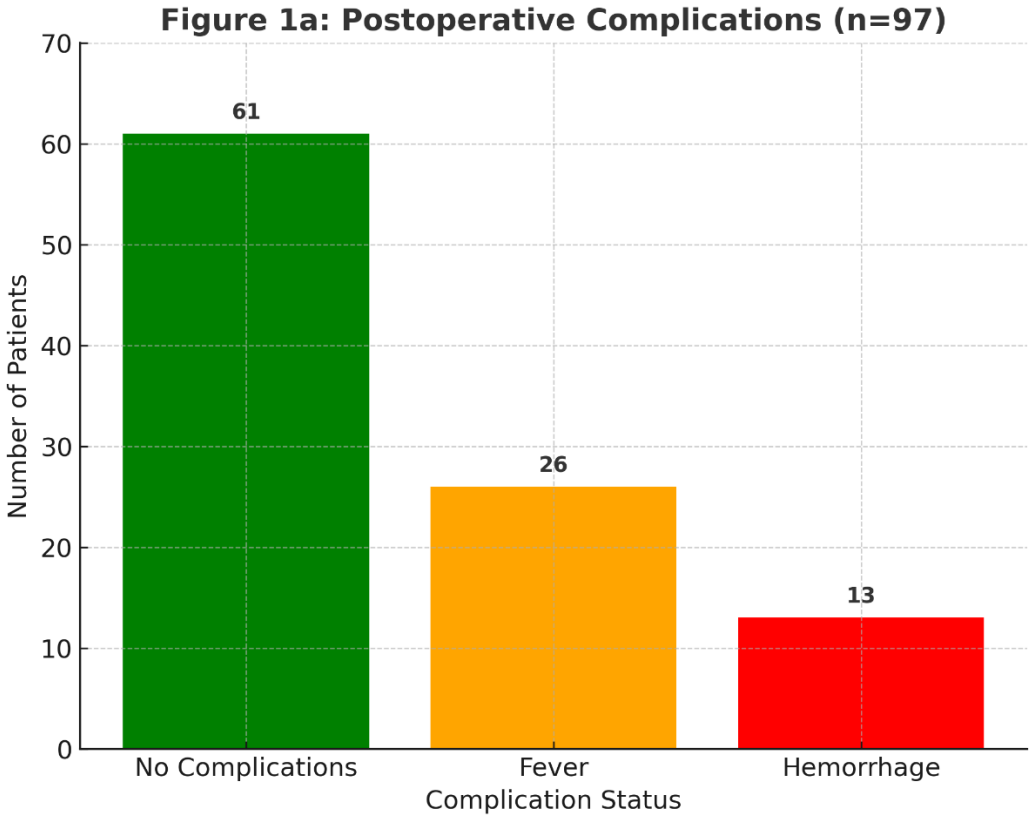
Outcome/Complication	Frequency (n (%))
No Complications	**61 (62.9%)**
Stone Clearance (Yes)	**44 (45.4%)**

Figure 1: Bar chart showing the distribution of postoperative complications.



Inferential statistical analysis was performed to identify associations between patient factors and complications. Chi-square tests revealed no significant association between gender and the incidence of fever ($\chi^2 = 0.289$, $p = 0.591$) or hemorrhage ($\chi^2 = 0.158$, $p = 0.691$). Stone location was also not a significant predictor of fever ($\chi^2 = 1.577$, $p = 0.665$). Independent samples t-tests showed no significant differences in age ($t = 0.607$, $p = 0.545$) or BMI ($t = 0.254$, $p = 0.800$) between genders. Furthermore, there were no

Health Affair, ISSN - 0278-2715
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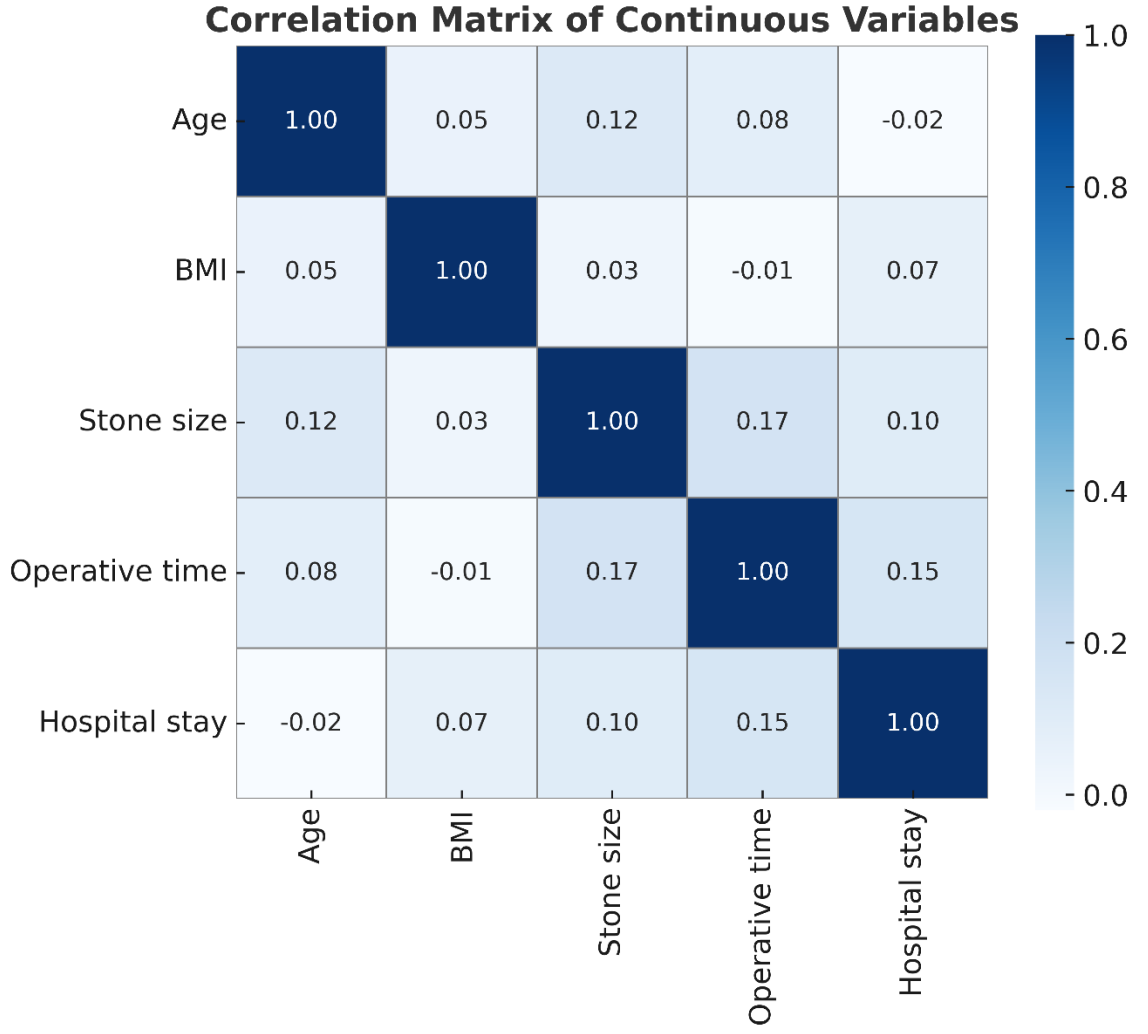
significant differences in stone size (t = -0.623, p = 0.534) or operative time (t = 0.119, p = 0.906) between patients who developed fever and those who did not.

A correlation analysis examining continuous variables is depicted in **Figure 2**. The heatmap shows weak and non-significant correlations between all variables, including age, BMI, stone size, operative time, and hospital stay. The strongest correlation, though still not statistically significant (p > 0.05), was observed between stone size and operative time (r = 0.166)



DISCUSSION

This study aimed to determine the frequency of early postoperative complications of PCNL in a tertiary care setting in Khyber Pakhtunkhwa. Our analysis revealed an overall complication rate of 37.1%, which resides within the broad range of 20–83% reported in the global literature for PCNL[6]. This rate is higher than the 21.9% reported in a recent large multicenter study[13] but is consistent with other single-center experiences,

highlighting the variability inherent in comparing outcomes across different patient populations, surgical expertise, and definitions of complications.

The most common complication in our cohort was postoperative fever (26.8%), aligning well with established rates of 10–30%[8,14]. While often a transient inflammatory response, fever is a critical clinical indicator for potential sepsis, a serious albeit rarer complication. Our finding contrasts with a 2025 study that reported a notably higher fever rate of 51.0%[15], but is consistent with a meta-analysis reporting 9.5%[16], underscoring the significant heterogeneity in reporting this outcome. Interestingly, unlike other studies that identified larger stone size (>25mm) and longer operative duration (>120 minutes) as key predictors of severe infectious complications[17], our analysis found no such associations. This discrepancy could be attributed to our relatively shorter mean operative time (29.5 minutes), effective adherence to perioperative antibiotic prophylaxis protocols[18], or a sample size underpowered to detect such relationships.

Postoperative hemorrhage was defined as hematuria ≥3 RBC/HPF or ≥50 RBC/µL, occurred in 13.4% of patients. While hematuria is a very common early event[19], the rate of severe bleeding requiring transfusion is typically much lower (1-5.5%) (10, 11). Our broader definition likely captured more minor, self-limiting episodes. A comprehensive 2025 meta-analysis identified diabetes, hypertension, and larger stone size as risk factors for severe bleeding[20]. Our exclusion of patients with bleeding tendencies and cardiovascular diseases may have selected a lower-risk cohort, explaining the lack of a significant link between these variables and hemorrhage in our study.

A pivotal finding of our research is the absence of statistically significant relationships between key patient demographics (age, gender, BMI) and the incidence of complications. This suggests that within carefully selected patients meeting our inclusion criteria, PCNL can be performed with a consistent safety profile across diverse demographic groups. The result concerning BMI is particularly noteworthy, as obesity is often considered a surgical risk factor. Our data is supported by studies concluding that PCNL outcomes are independent of BMI, affirming its role as a safe and effective procedure for patients of all sizes[21]. Similarly, the lack of a gender-based difference aligns with some reports, though others have noted variations in specific complication risks[9,22].

Finally, the stone clearance rate in our study was 45.4%, which is lower than the >80% rates often cited in high-volume centers. This is likely a reflection of our study's definition of "stone-free," the high complexity of stones in our cohort (mean size 35.5mm), and the routine use of postoperative imaging to identify even small, clinically insignificant residual fragments. Staghorn stones and larger stone burden are well-documented predictors of residual stones (23, 24), which were prevalent in our patient population.

Limitations: This study has several limitations. Its single-center, descriptive design may limit the generalizability of the findings. The use of non-probability consecutive sampling could introduce selection bias. The sample size, though calculated, may still be underpowered to detect significant associations for less common complications or risk factors with smaller effect sizes. Lastly, the non-use of a standardized complication grading system (e.g., Clavien-Dindo) makes direct comparisons with other studies more challenging.

CONCLUSION

The study found that early postoperative complications following PCNL, primarily fever and hematuria, occur in over a third of patients in our setting. The procedure demonstrated a consistent safety profile across different ages, genders, and BMIs within our selected cohort. The analyzed demographic and operative variables were not strong independent predictors of adverse events, suggesting that PCNL is a robust procedure whose outcomes may be more influenced by surgical technique, stone complexity, and institutional protocols than by patient demographics alone. These findings contribute valuable real-world data from a tertiary care center in Khyber Pakhtunkhwa to the global understanding of PCNL outcomes.

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