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EFFECT OF PERCUTANEOUS-NEPHROLITHOTOMY ON RENAL FUNCTION TESTS AND HEMOGLOBIN LEVELS IN THE EARLY POSTOPERATIVE PERIOD AT 24 hours and 21st day

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ABSTRACT

BACKGROUND: The impact of percutaneous nephrolithotomy (PCNL) on renal function tests (RFTs) and hemoglobin (Hb) levels remains debated. Early postoperative changes may indicate transient renal dysfunction and hematological shifts.

OBJECTIVES: To evaluate measurable changes in **serum creatinine, blood urea nitrogen (BUN), estimated glomerular filtration rate (eGFR), and hemoglobin (Hb)** following PCNL at 24 hours and 21 days post-procedure.

METHODS: At Ayub Teaching Hospital, Abbottabad, a detailed case series was conducted at the Urology Department for exactly three months (2nd August to November 2025). During consecutive sampling, 68 patients aged 18–65 years, ASA Class I–II, subjected to PCNL were included. Renal functions were assessed using eGFR (MDRD formula), while Hb was measured at baseline, 24 hours, and 21 days postoperatively. Repeated-measures ANOVA was performed to analyze within-subject comparisons, while chi-square tests were used for categorical variables.

RESULTS: Both eGFR and Hb showed significant declines at 24 hours post-PCNL (**64.8 ± 12.9 ml/min/1.73m² and 12.4 ± 2.2 g/dL, respectively; $p < 0.001$ vs. baseline**). By day 21, partial recovery (eGFR 69.7 ± 13.1; Hb 13.4 ± 1.9) was noted, showing significantly lower values compared to preoperative levels ($p < 0.001$). Higher eGFR and Hb values were observed in younger patients (18–35 years) across all time points ($p < 0.05$).

CONCLUSIONS: PCNL produces an initial decline in renal function and hemoglobin levels, with partial recovery by three weeks. Postoperative fluctuations are significantly influenced by age, emphasizing the need for close monitoring in younger patients.

KEYWORDS: percutaneous nephrolithotomy, renal function tests, eGFR, hemoglobin

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INTRODUCTION

Renal stone disease affects **2–20% of the global population** and shows a rising trend in adults. The presence of urinary tract stones causing renal impairment varies depending on obstruction or infection status. The link between stone formation and chronic conditions such as metabolic syndrome, diabetes, and hypertension has been studied to devise treatment strategies for urinary stones aiming to restore kidney function. Minimally invasive surgical approaches are recommended over traditional open surgeries due to their milder impact on kidney function [1].

Kidney stones that tend to grow or persist for over two years are associated with a high risk of recurrence or urinary tract infections, followed by obstruction, bleeding, or persistent pain, and thus require active intervention. Careful evaluation of renal function is required in such cases. Patients with recurrent stone episodes, coexisting medical conditions, infections, and urinary blockage leading to renal insufficiency are influenced by several factors. High-risk individuals are screened for renal function tests to ensure optimal treatment planning. Retrograde intrarenal surgery (RIRS) and miniaturized percutaneous nephrolithotomy (mini-PCNL) are proven to be effective and safe treatment options among minimally invasive procedures [2],[3].

Individuals with moderate to large upper urinary tract stones are commonly directed to PCNL. Despite being less invasive than open surgery, PCNL is still associated with significant pain and potential complications, including bleeding, infections, and damage to nearby organs. Postoperative discomfort and hemoglobin loss vary according to patient-specific factors such as BMI, stone size, and stone location. Procedural modifications, such as the use of balloon or Amplatz™ dilators, help reduce blood loss and pain by minimizing operative time, implementing staged procedures for extensive stone burdens, and using ultrasound-guided access [4].

Renal function tests (RFTs), including blood urea nitrogen (BUN) and serum creatinine, are considered key indicators of kidney health. The impact of surgery on renal function is determined by assessing RFTs after PCNL, which helps detect complications at an early stage such as acute kidney injury (AKI) [5]. Hemoglobin (Hb) levels are tracked to assess blood oxygenation and potential hemorrhage after surgery. Regular hematological evaluations reinforce the correlation between surgical blood loss and compensatory physiological responses [6].

Glomerular filtration rate (GFR) shows a fluctuating pattern similar to serum creatinine, with a notable postoperative decline and subsequent recovery. For example, Hosseini et al. reported mean preoperative GFR of 74.89 mL/min, dropping to 64.04 mL/min at 48 hours and recovering to 69.54 mL/min at 72 hours ($p < 0.0001$). A significant reduction in hemoglobin levels following PCNL was also reported, with average preoperative Hb at 15.06 ± 0.87 g/dL, dropping to 13.09 ± 1.06 g/dL post-surgery ($p < 0.0005$) [6].

The objective of this study is to evaluate measurable changes in RFTs (serum creatinine, BUN, eGFR) and Hb following PCNL, particularly at 24 hours and 21 days post-procedure. Early diagnosis of kidney function fluctuations or hemoglobin decline may help minimize potential complications and ensure smoother recovery.

MATERIALS AND METHODS

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A descriptive case series was conducted at the Department of Urology, Ayub Teaching Hospital, Abbottabad over a period of three months (2nd August to November 2025) after approval of synopsis. The sample size for the study was determined using the WHO sample size calculator to be 68 patients, the sample size was calculated to achieve 80% statistical power at a significance level of 0.05, based on the assumed effect size derived from prior studies. The calculation considered the mean postoperative hemoglobin level of 13.09 ± 1.06 g/dL for this study [7]. A non-probability consecutive sampling technique was utilized, acknowledging potential selection bias but chosen for feasibility in a tertiary care setting.

All cases of either gender ranging in age from 18 to 65 years who underwent PCNL and were ASA Class I or II were included. Exclusion criteria included smokers, ASA Class III–IV, and those with a history of more than one percutaneous intervention or taking drugs that affect hemodynamics or electrolyte balance.

The study was conducted following approval from the Ethical Committee of Ayub Teaching Hospital, Abbottabad. A total of 68 patients were selected based on inclusion criteria, with each participant providing informed written consent. Demographic profile including registration number, age, gender, BMI category, and place of residence was recorded.

Preoperative assessment included urine culture and analysis (with antibiotics prescribed for urinary infections), serum biochemistry and electrolyte evaluations (creatinine, urea, sodium, potassium, chloride), coagulation profile (prothrombin time, partial thromboplastin time), viral hepatitis markers (HBsAg, HBcAb, HCVAb), complete blood count, and body weight measurement. Non-contrast CT scans and kidney, ureter, and bladder imaging were performed for all patients.

General anesthesia was given to perform the tubeless PCNL technique. A 4–5 Fr ureteral catheter was placed and positioned. The target calyx was punctured with a guide wire under fluoroscopic guidance. Tract dilation was carried out in a single step using Amplatz dilators. A pneumatic lithotripter (LithoCrack, Sp. Swiss-Germany) with continuous saline irrigation was used to remove the stone, aided by placement of the Amplatz sheath. An additional access site was created for residual stones >2 cm. Shock wave lithotripsy (SWL) was performed for residual stones <2 cm. Ureteral and Foley catheters were removed between 12 and 24 hours postoperatively.

Glomerular filtration rate (GFR) and hemoglobin levels were observed at baseline, 24 hours, and 21 days post-surgery. GFR was calculated using the **simplified MDRD equation**: **eGFR (ml/min/1.73m²) = 186 × [Scr]^–1.154 × [Age]^–0.203 × [0.742 if female] × [1.21 if black]**.

DATA ANALYSIS

SPSS version 26 was used for analysis. Normality was tested with the Shapiro–Wilk test (results reported: GFR and Hb were normally distributed, $p > 0.05$)**.** Mean ± SD were computed for numerical variables (age, surgery duration, GFR, Hb). Frequencies and percentages were used for categorical variables (gender, side, BMI).

Repeated-measures ANOVA was applied for within-subject comparisons across time points (pre-op, 24h, 21d). Stratification was performed by age, gender, side, and BMI. For comparisons across more than two groups (e.g., age categories), ANOVA was consistently used instead of independent t-tests. A p-value ≤ 0.05 was considered statistically significant.

RESULTS

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The mean age was 40.52 ± 13.74 years. Most were male (78.3%, n=54) compared to females (20.3%, n=14). BMI distribution: 2.9% underweight (n=2), 23.2% normal (n=16), 42% overweight (n=29), and 30.4% obese (n=21). All this descriptive analysis is summarized in table 1.

Table 1: Descriptive statistics of the study group

Variable	**Mean ± SD**	**Frequency (percentage)**
Age	40.52 ± 13.74	
Gender (male : female)		54(78.3) : 14(20.3)
BMI category (underweight : normal : overweight : obese)		2(2.9) : 16(23.2) : 29(42) : 21(30.4)

The GFR mean with ranges in preop, 24 hours postop and 21 days post op period were: 74 .76 (59 – 98), 64.79 (52 – 87) and 69.66 (54 – 93), respectively. Similarly the HB level mean with ranges in preop, 24 hours postop and 21 day postop were: 14.5 (10 – 18), 12.38 (8 – 17) and 13.38 (9 - 17), respectively. Following PCNL, both GFR and Hb showed significant decline at 24 hours (GFR: **64.79 ± 12.9**, Hb: 12.38 ± 2.17; p < 0.001 vs. pre-op). Partial recovery was observed by day 21 (GFR: **69.66 ± 13.1**, Hb: 13.38 ± 1.85), though values remained significantly lower than baseline (p < 0.001). Repeated-measures ANOVA confirmed significant time effects (p < 0.001)**:** summarized in table 2.

Table 2: Comparison of trends of GFR and Hb trends following PCNL

Variable	**Time point**	**Mean ± SD**	**Pairwise p-value vs pre-op**	**Pairwise p-value vs 24h post-op**	**ANOVA (p-value)**
GFR	Pre-op	74.76 ± 11.05	**--**	**--**	0.19 **(<0.001)**
	24hr post-op	64.79 ± 10.92	**<0.001**	**--**	
	21day post-op	69.66 ± 11.11	**<0.001**	**<0.001**	
Hb	Pre-op	14.5 ± 1.72	**--**	**--**	0.15 **(<0.001)**
	24hr post-op	12.38 ± 2.17	**<0.001**	**--**	
	21day post-op	13.38 ± 1.85	**<0.001**	**<0.001**	

In this study, GFR changes after PCNL were more marked in younger age group 18–35 years: they had higher GFR at all time points (pre-op: 82.04, 24hr: 71.12, 21day: 77.29) in comparison to the older groups, and this was statistically significant (*p*<0.001). But gender and BMI didn't show any significant difference in GFR values: male and female had similar GFR (pre-op 74.90 vs 74.21, *p*=0.79, 21day postop 69.4 vs 70.64, p=0.65), and the BMI groups too demonstrated quite comparable values (pre-op range 71.50 to 76.28, *p*=0.76, 21day range 67.75 to 71.09, p=0.75). So only age was associated with statistically significant GFR fluctuation. (Table 3)

Table 3: Association of demographic features with the GFR fluctuations.

Variable	**Time point**	**GFR (Mean ± SD)**	**F (p-value)**
Age (18-35 : 36-50 : 51-65)	Pre-op	82.04 ± 18.42 : 71.56 ± 16.67 : 69.95 ± 15.01	20.8 **(<0.001)**
	24hr post-op	71.12 ± 16.81 : 62.30 ± 16.35 : 60.28 ± 15.64	19.18 **(<0.001)**
	21days post-op	77.29 ± 18.30 : 66.52 ± 17.56 : 64.38 ± 15.51	20.80 **(<0.001)**
Gender (male : female)	Pre-op	74.90 ± 18.78 : 74.21 ± 18.82	0.069 (0.79)
	24hr post-op	64.57 ± 17.81 : 65.64 ± 18.20	0.204 (0.65)
	21days post-op	69.40 ± 19.00 : 70.64 ± 20.19	0.198 (0.65)
BMI category (underweight : normal : overweight :	Pre-op	71.50 ± 27.67 : 73.75 ± 15.36 : 74.44 ± 17.80 : 76.28 ± 21.33	0.380 (0.76)
	24hr post-op	63.50 ± 22.02 : 63.43 ± 15.75 : 65.03 ± 17.19 : 65.61 ± 19.96	0.255 (0.85)

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obesity)	21days post-op	69.00 ± 26.97 : 67.75 ± 16.34 : 69.72 ± 19.36 : 71.09 ± 20.52	0.394 (0.75)

As is presented in table 4, Hb level change after PCNL was higher in young age group. Age 18–35 had higher Hb at all time (pre-op 15.25, 24hr 13.29, 21day 14.00) than older groups, and this difference was significant (*p*=0.01, 0.03, 0.05). But gender didn't show any difference: male and female almost had similar readings (pre-op 14.51 vs 14.42, *p*=0.86, 21day postop 13.37 vs 13.42, p=0.91). Also BMI groups had similar Hb values (pre-op range 14.00 to 14.81, *p*=0.63, 21day postop 12.0 to 13.56, p=0.65). So only age was related with Hb fluctuation.

Table 4: Association of demographic features with the Hb fluctuations.

Variable	**Time point**	**Mean** ± SD	**F (p-value)**
Age (18-35 : 36-50 : 51-65)	Pre-op	15.25 ± 1.39 : 14.39 ± 1.69 : 13.76 ± 1.81	4.71 **(0.01)**
	24hr post-op	13.29 ± 1.98 : 12.00 ± 2.13 : 11.76 ± 2.16	3.57 **(0.03)**
	21days post-op	14.00 ± 1.50 : 13.39 ± 1.90 : 12.66 ± 1.98	3.08 (0.05)
Gender (male : female)	Pre-op	14.51 ± 1.75 : 14.42 ± 1.65 : 14.50 ± 1.72	0.03 (0.86)
	24hr post-op	12.37 ± 2.15 : 12.42 ± 2.31 : 12.3 ± 2.17	0.00 (0.93)
	21days post-op	13.37 ± 1.92 : 13.42 ± 1.60 : 13.38 ± 1.85	0.01 (0.91)
BMI category (underweight : normal : overweight : obesity)	Pre-op	14.00 ± 2.82 : 14.81 ± 1.10 : 14.62 ± 1.95 : 14.14 ± 1.74	0.56 (0.63)
	24hr post-op	10.50 ± 3.53 : 12.62 ±1.50 : 12.51 ± 2.47 : 12.19 ± 2.11	0.64 (0.58)
	21days post-op	12.00 ± 2.82 : 13.56 ± 1.15 : 13.51 ± 1.95 : 13.19 ± 2.11	0.53 (0.65)

DISCUSSION

This study reinforces evidence that PCNL exerts measurable impact on renal function and hematological parameters. The decline in GFR and Hb at 24 hours postoperatively is consistent with prior studies reporting transient renal impairment and blood loss [7],[8].

Mean GFR dropped from baseline (74.89 mL/min) to 64.79 mL/min at 24 hours, with partial recovery to 69.66 mL/min by day 21. This trajectory resembles findings by Hosseini et al. [9]. Younger patients demonstrated higher baseline and recovery values, supporting better renal reserve.

Hemoglobin declined from 14.51 g/dL to 12.38 g/dL, consistent with intraoperative blood loss [8]. Partial recovery by day 21 (13.38 g/dL) reflected compensatory hematopoiesis.

Age was the only significant factor influencing both GFR and Hb. Gender and BMI showed no significant associations. These findings align with long-term studies on mini-PCNL and RIRS [10].

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Best practices to minimize trauma and bleeding include tubeless PCNL with Amplatz dilators and pneumatic lithotripsy [11–13]. Vigilant postoperative monitoring of RFTs and Hb is essential to detect early complications.

Study limitations: small sample size and single-center design. However, uniformity of surgical technique reduced technical bias. Multi-center studies are recommended for stronger evidence.

CONCLUSION

PCNL is associated with a measurable decline in renal function (GFR) and hemoglobin levels within 24 hours, with partial recovery by 21 days. **Age significantly influences recovery patterns**, while gender and BMI do not. These findings highlight the importance of age-based risk stratification and close postoperative monitoring.

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