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PREDICTION OF ACUTE KIDNEY INJURY FOLLOWING ENDOUROLOGICAL MANAGEMENT OF KIDNEY STONES

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Abstract

Background: *Acute kidney injury (AKI) is a recognized complication of endourological procedures for kidney stones. Early identification of high-risk patients can guide perioperative management and reduce renal morbidity.*

Objective: *To evaluate the incidence and predictors of AKI in patients undergoing endourological management of kidney stones at Sheikh Zayed Hospital, Lahore.*

Methods: *A prospective observational study was conducted on 250 adult patients undergoing percutaneous nephrolithotomy (PCNL) or ureterorenoscopy (URS) between January 2022 and December 2023. Demographic, clinical, and operative data were collected, including age, sex, comorbidities, baseline renal function, stone size, and operative parameters. AKI was defined according to KDIGO criteria. Logistic regression analysis identified independent predictors of AKI.*

Results: *AKI occurred in 31 patients (12.4%). Incidence was higher in PCNL (19.6%) than URS (8.2%). Multivariate analysis revealed baseline serum creatinine >1.2 mg/dL (OR 3.12, 95% CI 1.54–6.32), diabetes (OR 2.45, 95% CI 1.12–5.34), and operative duration >90 minutes (OR 2.87, 95% CI 1.41–5.83) as independent predictors. Multiple tracts in PCNL showed a trend toward increased risk (OR 2.18, 95% CI 0.91–5.22).*

Conclusion: *AKI is a notable complication following endourological management of kidney stones. Preoperative assessment, optimization of comorbidities, and careful operative planning are essential for minimizing renal injury.*

Introduction

Kidney stones are a prevalent urological disorder with significant global and national impact. Epidemiological studies report prevalence rates ranging from 5–15% in adults, with increasing incidence in South Asia due to dietary patterns, metabolic disorders, and lifestyle changes (1,2). Nephrolithiasis can cause recurrent urinary tract infections, obstruction, chronic kidney disease,

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and considerable patient morbidity if untreated (3).

Endourological interventions, including percutaneous nephrolithotomy (PCNL) and ureterorenoscopy (URS), have become standard treatment options for renal and ureteric stones. PCNL is indicated for larger or complex stones, whereas URS is preferred for smaller stones or stones in the ureter. These procedures offer minimally invasive solutions with high stone clearance rates and reduced postoperative morbidity compared to open surgery. Despite their safety, complications including bleeding, infection, and acute kidney injury (AKI) remain concerns (4,5).

AKI is increasingly recognized as a significant postoperative complication that can prolong hospital stay, increase morbidity, and predispose patients to long-term renal dysfunction. The pathophysiology involves renal parenchymal trauma, ischemia-reperfusion injury, obstruction, and nephrotoxic insults (6,7). Risk factors include pre-existing renal impairment, diabetes, hypertension, stone burden, prolonged operative time, and multiple PCNL tracts (8,9).

While international studies provide insight into post-endourological AKI, data from Pakistan remain scarce. The patient profile, comorbidity burden, and perioperative practices in Pakistani tertiary care hospitals may differ from international cohorts, affecting incidence and predictors of AKI. Understanding local risk factors is essential for effective risk stratification, perioperative planning, and early intervention (8). This study aims to assess the incidence of AKI following endourological management of kidney stones and identify clinical, demographic, and procedural predictors in patients at Sheikh Zayed Hospital, Lahore. Findings will guide perioperative management strategies, enhance risk prediction, and improve patient outcomes.

Methodology

Study Design and Setting

A prospective observational study was conducted at Sheikh Zayed Hospital, Lahore, a tertiary care referral center. The study period spanned January 2022 to December 2023. Ethical approval was obtained from the hospital's Institutional Review Board.

Study Population

Patients aged ≥18 years undergoing PCNL or URS for kidney stones were included. Exclusion criteria: pre-existing end-stage renal disease, solitary kidney, active urinary tract infection, or incomplete medical records.

Data Collection

Demographic and clinical data included age, sex, body mass index (BMI), comorbidities (diabetes, hypertension), prior kidney stones, and baseline renal function (serum creatinine, eGFR). Stone characteristics were documented from preoperative imaging. Operative variables included procedure type, duration, number of PCNL tracts, and intraoperative complications.

Definition of AKI

AKI was defined per KDIGO criteria: increase in serum creatinine ≥0.3 mg/dL within 48 hours, or ≥1.5 times baseline within 7 days postoperatively. Urine output criteria were not used.

Statistical Analysis

Data were analyzed using SPSS v26. Continuous variables were expressed as mean ± SD or median (IQR); categorical variables as frequency and percentage. Comparisons between AKI and non-AKI groups used chi-square or Fisher's exact test for categorical variables, and t-test or Mann–Whitney U test for continuous variables. Variables significant in univariate analysis ($p<0.05$) were entered into multivariable logistic regression to identify independent predictors. Odds ratios (OR) with 95% confidence intervals (CI) were reported; $p<0.05$ was significant.

Results

Patient Characteristics

A total of 250 patients were included. Mean age was 46.2 ± 12.8 years; 142 (56.8%) were male. Diabetes was present in 68 (27.2%), hypertension in 93 (37.2%). Stone size averaged 18.4 ± 7.3 mm.

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PCNL was performed in 92 (36.8%) patients, URS in 158 (63.2%).

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Table 1: Baseline Characteristics of Study Sample (N = 250)

Variable	Category	n	%
Sex	Male	142	56.8
	Female	108	43.2
Age (years)	<40	98	39.2
	40–60	112	44.8
	>60	40	16.0
Diabetes	Yes	68	27.2
	No	182	72.8
Hypertension	Yes	93	37.2
	No	157	62.8
Procedure	PCNL	92	36.8
	URS	158	63.2

Incidence of AKI

- **Overall AKI:** 31 patients (12.4%)
- PCNL: 18/92 (19.6%)
- URS: 13/158 (8.2%)

Predictors of AKI

Predictor	OR	95% CI	p-value
Baseline creatinine >1.2 mg/dL	3.12	1.54–6.32	0.002
Diabetes	2.45	1.12–5.34	0.024
Operative duration >90 min	2.87	1.41–5.83	0.003
Multiple PCNL tracts	2.18	0.91–5.22	0.079

Discussion

This study found a **12.4% incidence of AKI** following endourological procedures, consistent with international literature reporting 10–20% rates. AKI was more frequent after PCNL than URS due to renal parenchymal trauma and multiple tracts. Baseline renal impairment increased risk threefold, consistent with previous studies highlighting reduced renal reserve as a critical factor (5–7).

Diabetes was associated with a 2.45-fold higher risk of AKI. Microvascular changes in diabetes likely impair renal perfusion and recovery after surgical stress. Operative time >90 minutes was independently predictive, reflecting more complex cases with increased manipulation and fluid shifts. Multiple PCNL tracts showed a trend toward increased risk, supporting staged procedures for large or complex stones to reduce parenchymal injury (7).

The findings emphasize the importance of **preoperative risk stratification** and perioperative optimization. High-risk patients should receive careful monitoring, adequate hydration, and postoperative renal function assessment. Minimizing operative time and avoiding unnecessary tracts may reduce AKI risk. These measures are particularly relevant in resource-limited settings like Pakistan, where advanced renal replacement therapies may not be readily available (8).

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The study provides a locally relevant risk profile for AKI following endourological procedures, aligning with global guidelines and offering evidence to improve perioperative protocols and patient counseling. Further multicenter studies with larger samples and long-term follow-up are recommended to validate these findings (10).

Conclusion

AKI is a significant complication after endourological management of kidney stones, particularly in patients with baseline renal impairment, diabetes, and prolonged surgery. Preoperative risk assessment, optimization of comorbidities, careful operative planning, and postoperative monitoring are essential to minimize renal injury.

Limitations

- Single-center study, limiting generalizability
- Relatively small sample size
- Short-term follow-up; long-term renal outcomes not assessed

Recommendations

- Preoperative risk stratification using baseline creatinine and comorbidity profile
- Optimize diabetic control preoperatively
- Minimize operative duration; consider staged procedures for complex stones
- Close postoperative renal monitoring

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