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COMPLICATIONS ANALYSIS OF PERCUTANEOUS NEPHROLITHOTOMY: AN INSIGHT FROM A TERTIARY CARE HOSPITAL

Original Research

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ABSTRACT

Background: Renal stone disease is a common urological condition affecting a significant proportion of the global population. For stones larger than 2 cm, percutaneous nephrolithotomy (PCNL) is recommended as the first-line treatment by both the European Association of Urology and the American Urological Association. While PCNL offers high stone clearance rates, it is associated with a range of complications. Understanding these risks is essential to improve perioperative outcomes and enhance patient safety.

Objective: To evaluate the intra-operative and early post-operative complications associated with PCNL in patients presenting with renal stones at a tertiary care hospital.

Methods: This prospective descriptive study was conducted in the Department of Urology at the Institute of Kidney Diseases, Peshawar, over a six-month period from October 2024 to March 2025. A total of 174 patients aged 18–65 years who underwent elective PCNL were enrolled using a consecutive non-probability sampling technique. Patient demographics, clinical data, and complications were documented using a structured proforma. All procedures were performed under general anesthesia, and complications were recorded according to predefined criteria. Statistical analysis was conducted using IBM SPSS version 23.

Results: Among the 174 patients, 96 (55.2%) were males and 78 (44.8%) females, with a mean age of 41.7 ± 13.12 years. The mean stone size was 29.5 ± 6 mm, and the average stone density was 1409.9 ± 116 HU. Stone clearance was achieved in 140 (80.5%) patients. Intra-operative complications included hypotension in 4 (2.3%) patients, severe bleeding requiring transfusion in 9 (5.2%), and renal pelvis perforation in 5 (2.9%). Post-operative complications included fever in 44 (25.3%), hematuria in 38 (21.8%), urine leakage in 11 (6.3%), and urosepsis in 5 (2.9%). Angio-embolization was required in 2 (1.1%) cases. Most complications were managed conservatively.

Conclusion: PCNL is a relatively safe and effective procedure for the management of large renal stones; however, awareness and prompt management of potential complications are essential to minimize morbidity.

Keywords: Hematuria, Nephrostomy, Percutaneous nephrolithotomy, Postoperative complications, Renal calculi, Stone clearance, Urosepsis.

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INTRODUCTION

Renal stone disease is one of the most prevalent urological conditions worldwide, accounting for 80–90% of all urinary tract calculi (1). It is estimated that up to 12% of the global population will experience urinary stones at some point in their lives (2). Over recent decades, a notable rise in the incidence of urolithiasis has been observed, a trend attributed primarily to modern lifestyle changes, including sedentary behavior and dietary habits such as high sodium intake and low fluid consumption (3,4). Beyond the immediate discomfort and morbidity associated with stone formation, renal stones have been implicated as significant risk factors for long-term complications, including chronic kidney disease and end-stage renal failure (5). The management of urolithiasis has been revolutionized by technological advancements, shifting from traditional open surgeries to more refined and less invasive techniques. Among these, minimally invasive procedures such as standard percutaneous nephrolithotomy (PCNL), mini-PCNL, and laparoscopic ureterolithotomy have become the preferred approaches in recent years due to their improved safety profiles and effectiveness (6). Introduced by Fernstrom and Johansson in 1976, PCNL provided a much-needed alternative for patients who were not suitable candidates for open surgery, offering a percutaneous route for stone extraction that drastically reduced recovery time and postoperative morbidity (7).

Currently, PCNL is recognized as the standard treatment for renal stones greater than 2 cm in size, as recommended by the European Association of Urology (6). Similarly, the American Urological Association endorses PCNL as the first-line treatment for complex staghorn calculi due to its superior stone clearance rates (8). Despite its clinical efficacy, PCNL is not without risk. A range of complications can occur, including intraoperative bleeding, urinary leakage from nephrocutaneous fistulae, postoperative pain, and in severe cases, systemic infections such as sepsis (9). Complication rates reported in the literature vary widely, ranging from 20% to 83%, underscoring the influence of surgical technique, instrumentation, and patient-specific factors (10). Such wide-ranging variation in complication rates highlights a critical gap in standardized understanding and reporting. There is a need for focused studies to assess and document the specific complications associated with PCNL, particularly in local clinical settings where patient profiles and surgical expertise may differ from global norms. By systematically analyzing these complications, healthcare providers can better anticipate adverse events, refine surgical practices, and ultimately enhance patient outcomes. In light of this, the present study aims to evaluate the spectrum and frequency of complications following PCNL in patients undergoing treatment at a tertiary care hospital. Through this analysis, the study seeks to contribute meaningful data to existing literature and support improved clinical decision-making in urological surgery.

METHODS

This prospective, cross-sectional descriptive study was conducted in the Department of Urology at the Institute of Kidney Diseases, Peshawar, over a period of six months from October 2024 to March 2025, following ethical approval from the Institutional Review and Ethical Board (Certificate No. 461/chairman/R&E/committee). Written informed consent was obtained from all participants after they were fully briefed regarding the purpose, procedures, and potential risks and benefits of the study. A total of 174 patients were enrolled through consecutive non-probability sampling. The sample size was calculated using the OpenEpi sample size calculator, with assumptions of 80% study power, 95% confidence interval, 5% margin of error, and an expected outcome prevalence of 20% among the exposed group. Inclusion criteria comprised adult patients aged 18 to 65 years with a confirmed diagnosis of renal stone disease who were scheduled for elective percutaneous nephrolithotomy (PCNL). Patients were excluded if they were pregnant, had ongoing urinary tract infections, or had known coagulation disorders. All procedures were carried out under general anesthesia, beginning with the patient placed in the lithotomy position. Cystoscopy was performed to allow passage of a guidewire into the ipsilateral ureter, reaching up to the renal pelvis or proximal ureter. A 6 Fr ureteric catheter was then advanced over the guidewire, and a per-urethral catheter was also placed, both of which were secured using Nichiban tape. Following this, patients were repositioned into the prone position, prepared, and draped in a sterile manner. Fluoroscopic imaging was used to instill contrast into the pelvicalyceal system via the ureteric catheter, facilitating a targeted percutaneous puncture using a TLA needle. Confirmation of entry was achieved via negative suction with a 5cc syringe, after which a glidewire was inserted. Tract length was determined, and serial dilatation was carried out under fluoroscopic guidance to the required diameter.

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Nephroscopy was subsequently performed to locate and fragment renal stones using a pneumatic lithoclast. Fragments were retrieved until the fluoroscopy confirmed complete stone clearance. A 6 Fr Double-J stent was placed antegradely, and a nephrostomy tube was inserted only if clinically indicated. The Double-J stent was removed for two weeks postoperatively. Postoperative complications such as fever, urinary leakage, and sepsis were recorded as per predefined operational definitions. Data collection was carried out using a structured proforma. Statistical analysis was performed using IBM SPSS Statistics version 23. Continuous variables were expressed as mean ± standard deviation (SD) for normally distributed data or median with interquartile range (IQR) for skewed data. Categorical variables, including rates of postoperative complications, were presented as frequencies and percentages. The Chi-square test was used to evaluate associations between categorical variables, while Fisher's exact test was applied in instances where expected cell counts were below 5. A p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 174 patients were enrolled in the study, consisting of 96 males (55.2%) and 78 females (44.8%), with a mean age of 41.7 ± 13.12 years. The average stone size measured was 29.5 ± 6 mm, and the mean stone density was 1409.9 ± 116 Hounsfield Units. Among these patients, 23 (13.2%) had a history of previous stone surgery, and 11 (6.3%) had a pre-operative Double-J (DJ) stent placed. Successful stone clearance was achieved in 140 patients, corresponding to an overall clearance rate of 80.5%. Intra-operative complications were relatively uncommon. Hypotension occurred in 4 patients (2.3%), severe intra-operative bleeding necessitating blood transfusion was observed in 9 patients (5.2%), and renal pelvis perforation was documented in 5 patients (2.9%). Early post-operative complications were more frequently observed. Fever was the most common, affecting 44 patients (25.3%). Hematuria was noted in 38 cases (21.8%), while urine leakage from the nephrostomy wound occurred in 11 patients (6.3%). An increase in post-operative serum creatinine was seen in 6 patients (3.4%), and 5 patients (2.9%) developed urosepsis, managed successfully with intravenous antibiotics. Wound infection was noted in 3 patients (1.7%), and 2 patients (1.1%) required angio-embolization due to persistent bleeding that did not respond to conservative measures.

Table 1. Patient Characteristics (n)

Parameter	Frequency	Percentage
Age in years (Mean ± S.D.)	41.7 ± 13.12 years	
Gender		
Male	96	55.2%
Female	78	44.8%
Previous stone surgery	23	13.2%
Mean stone size in mm	29.5 ± 6mm	
Mean stone density in HU	1409.9 ± 116 HU	
Pre-operative double-J stent placement	11	6.3%
Stone clearance	140	80.5%

Table 2. Intra-operative and post-operative complications (n)

Parameter	Frequency	Percentage
Intra-operative hypotension	4	2.3%
Intra-operative bleed	9	5.2%
Renal pelvis perforation	5	2.9%
Post-operative hematuria	38	21.8%
Post-operative fever	44	25.3%
Urine leakage from wound	11	6.3%
Blood transfusion	9	5.2%
Increase in post-op serum creatinine	6	3.4%
Urosepsis	5	2.9%
Wound infection	3	1.7%
Angio-embolization	2	1.1%

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Table 3: Patient Characteristics and Complications

	Parameter	Frequency	Percentage
0	Male	96	55.2
1	Female	78	44.8
2	Previous stone surgery	23	13.2
3	Pre-op DJ stent	11	6.3
4	Stone clearance	140	80.5
5	Intra-op hypotension	4	2.3
6	Intra-op bleed	9	5.2
7	Renal pelvis perforation	5	2.9
8	Post-op hematuria	38	21.8
9	Post-op fever	44	25.3
10	Urine leakage	11	6.3
11	Blood transfusion	9	5.2
12	1 post-op serum creatinine	6	3.4
13	Urosepsis	5	2.9
14	Wound infection	3	1.7
15	Angio-embolization	2	1.1

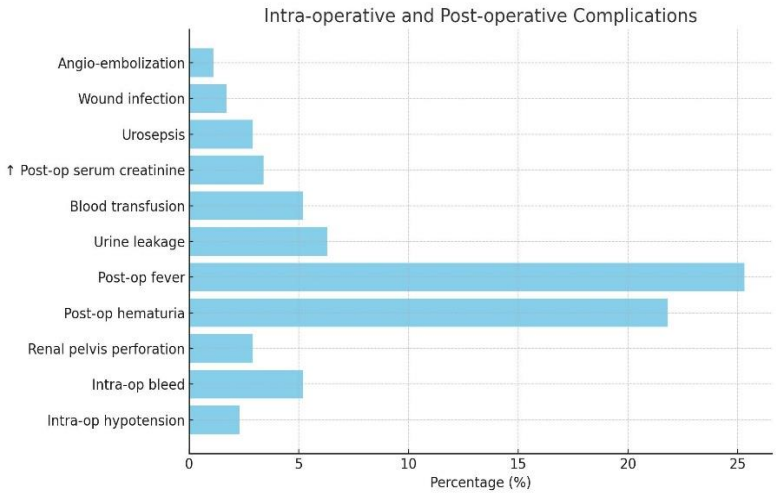

Figure 1 Intra-Operative and Post-operative Complications

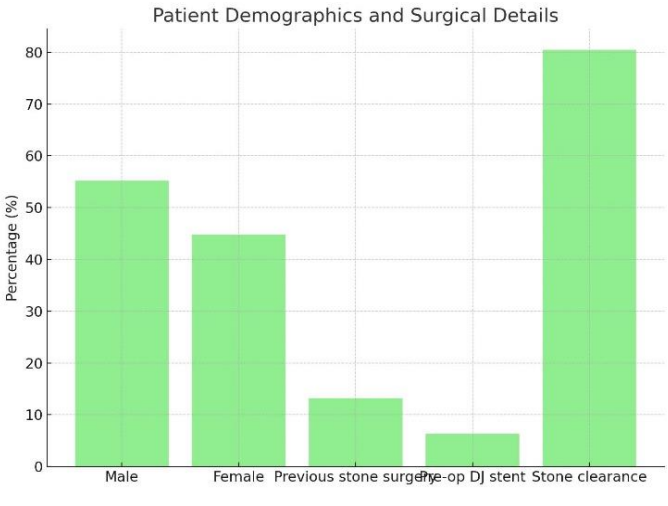

Figure 2 Patient Demographics and Surgical Details

DISCUSSION

Renal stone disease continues to pose a significant global health burden, with an estimated 5% prevalence in the United States and a considerable proportion—approximately 10% to 20%—classified as staghorn calculi, which demand timely and effective intervention to avoid irreversible renal damage and systemic complications (11). Percutaneous nephrolithotomy (PCNL) remains the gold standard for the management of large renal stones, particularly staghorn stones. Advances in PCNL techniques—ranging from standard to mini and micro PCNL—have expanded therapeutic options, each offering distinct benefits depending on patient anatomy, stone characteristics, and institutional expertise (12). The findings of the present study reinforce the well-established safety and efficacy profile of PCNL while highlighting its potential complications. Post-operative fever emerged as the most frequent complication, observed in

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25.3% of the cohort. This finding is in close agreement with previously reported literature, where fever rates following PCNL have ranged from 20% to 30% in various clinical settings (13). However, other studies have reported lower incidences, reflecting variability in patient comorbidities, surgical technique, and perioperative management protocols (14). The second most common complication was hematuria, noted in 21.8% of patients, which aligns with outcomes reported in similar studies evaluating PCNL outcomes in large-volume tertiary centers (15,16). Importantly, the majority of hematuria cases resolved spontaneously or with conservative management.

Intra-operative complications were less frequent but remain clinically relevant. Intra-operative hypotension (2.3%), severe bleeding necessitating transfusion (5.2%), and renal pelvis perforation (2.9%) are consistent with published rates, supporting the notion that while PCNL is minimally invasive, it is not devoid of intraoperative risks (17,18). In this study, all cases of severe bleeding were managed with transfusions, and renal pelvis injuries were successfully addressed via antegrade Double-J stenting, demonstrating effective intraoperative decision-making and complication control. Uncommon yet clinically significant post-operative complications included urine leakage (6.3%), transient elevations in serum creatinine (3.4%), urosepsis (2.9%), and wound infections (1.7%). The requirement of angio-embolization in 1.1% of patients due to persistent bleeding underscores the importance of having advanced interventional radiology support in centers performing high-risk PCNL procedures. These rates fall within the spectrum of previously reported outcomes and reflect real-world variability based on patient profiles and surgical expertise (19,20).

This study contributes valuable real-time evidence from a regional high-volume center, offering insights into the complication profile of PCNL in a representative cohort. One of its notable strengths is the comprehensive documentation of both intra-operative and early post-operative complications, providing a holistic view of PCNL-associated morbidity. Additionally, the use of clearly defined operational criteria for each complication enhances the reliability of the reported outcomes. Nonetheless, certain limitations must be acknowledged. Being a single-center study conducted at the Institute of Kidney Diseases, Peshawar, the findings may not be generalizable across different healthcare environments with varying patient demographics, institutional protocols, and resource availability. Moreover, the procedures were performed by multiple surgeons, introducing potential variability in technique and experience, which may have influenced complication rates. Standardizing surgical expertise or stratifying complication rates based on surgeon experience could enhance the validity of future research. Furthermore, the study did not account for factors such as stone burden, operative duration, hospital stay length, or long-term renal outcomes—parameters that are increasingly recognized as relevant to assessing the overall success of PCNL. Future studies should incorporate multicenter designs with standardized protocols and long-term follow-up to better evaluate the predictors of complications and refine patient selection criteria. Stratification by stone type, burden, and comorbidities may also offer nuanced insight into optimizing surgical planning and perioperative care. While PCNL remains a cornerstone in managing complex renal stones, a thorough understanding of its risk profile—as demonstrated in this study—is essential for improving surgical safety, patient counseling, and long-term outcomes.

CONCLUSION

Percutaneous nephrolithotomy remains a highly effective and generally safe intervention for the management of renal stones, particularly large and complex calculi. While most complications encountered are manageable with conservative or minimally invasive measures, the potential for serious adverse events underscores the importance of vigilant intra- and post-operative monitoring. This study highlights the spectrum of complications that can arise, reinforcing the need for skilled surgical execution and institutional readiness to manage unexpected outcomes. By offering a comprehensive overview of the procedural risks, these findings aim to support urologists in delivering safer, more informed, and patient-centered care.

AUTHOR CONTRIBUTION

Author	Contribution
Khizer Zaman	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Nauman ul Mulk	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Muhammad Tayyib	Substantial Contribution to acquisition and interpretation of Data

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Author	Contribution
	Has given Final Approval of the version to be published
Abdul Haseeb*	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Muhammad Afnan	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Raza Muhammad	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published

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