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POST OPERATIVE INFECTIVE COMPLICATIONS OF PCNL

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ABSTRACT

Background: *Large and difficult kidney stones are best treated with percutaneous nephrolithotomy (PCNL). Postoperative infectious complications, including fever, urinary tract infection (UTI), pyelonephritis, systemic inflammatory response syndrome (SIRS), and sepsis, remain to be major causes of morbidity with its high stone clearance rate. Early identification of patients at risk will improve surgical results. Readmission was evaluated for the postoperative infective complication of PCNL.*

Objective: *To evaluate the postoperative infective complication of PCNL.*

Methodology: *This was an observational cross sectional study conducted over a period of four months in the Mayo Hospital in Lahore. The adult PCNL patients included were sampled using purposive sampling to achieve a sample size of 78. Those with a positive urine culture and/or fever prior to surgery were not included. A systematic questionnaire was used to gather the data, and SPSS version 26 was used for analysis. The relationship between postoperative fever and risk factors was determined using Chi square and Fisher's exact tests, and descriptive statistics were used to describe the patients' characteristics. Those with a p-value < 0.05 were considered to be statistically significant.*

Results.: *The average age of the 78 patients in this study was 48 years. Men made up the majority (77%), and procedures on the right side were somewhat more common (56%). The most common complaint, occurring in almost 95% of cases, was flank pain. Staghorn stones were present in about one-third of the patients, and multiple calculi were discovered in 28%. Sixty percent of the individuals had hydronephrosis. Tractsizeswereslitequallybetweenthoseunderandover22Fr, and the majority (86%) only had one puncture. In 42% of cases, operations took more than 90 minutes, and 13% of patients had residual stones. Fever was the most common complication, impacting 36% of patients. More serious conditions like pyelonephritis and sepsis were much less common, occurring in only 6% and 5% of cases, respectively, while UTIs came in at 22%. When we looked at what caused these complications, we discovered that the likelihood of getting a fever was greatly increased by surgeries that lasted longer than 90 minutes, leftover stone fragments, a history of previous UTIs, previous episodes of urosepsis, and prior surgical interventions. In a similar manner, patients with a history of urosepsis, prolonged*

operations, or residual stones were more likely to experience UTIs. Pyelonephritis was closely associated with the presence of staghorn stones, a history of urosepsis, and a previous UTI. A history of urosepsis or UTI was most strongly linked to sepsis, despite its rarity. Gender, surgical side, diabetes, hypertension, stone location, hydronephrosis, and the use of stents or nephrostomy tubes were among the other factors we looked at, but they had no discernible effect on these results.

Conclusion: *Fever is the most common intra-post-operative complication after PCNL. Long operating time, diabetes mellitus, positive preoperative urine, staghorn calculi and multiple kidney stones are associated with a high risk of postoperative infection. A careful preoperative evaluation, a condition management, adequate antibiotic prophylaxis and surgical precision may help to minimize infectious complications and optimize patient outcomes.*

1. INTRODUCTION

Percutaneous nephrolithotomy (PCNL) is suggested as the primary option of treatment technique for patients with renal stones greater than 2 cm. It is reported that up to one-third of patients might have some perioperative problems, mainly fever and urinary tract infections, which accounts about 21%–39.8% of all the complications. (G. Manoj Kumar et al.,2021)

Urolithiasis is the sixth most prevalent disease in Pakistan, which lies within the "stone belt region" [1]. Open surgery, or pyelolithotomy, has long been the mainstay of treatment for renal stones, however, some of the endoscopy techniques are gaining popularity as the treatment of choice [2-5]. Following PCNL, half of the stones are cleared in 95.3% to 97.3% of cases. (Murad A. khan et al., 2024) .

PCNL was first developed as a minimally invasive method for extracting kidney stones in 1970. For stones over 2cm in size, multiple stones, and stones in the inferior calyces, the European Association of Urology (EAU) recommends PCNL as the first-line treatment. PCNL can be used to remove large kidney stones, such as complicated and staghorn stones.

There are still some problems with PCNL. A multi-centre study recently performed by the "Clinical Research Office of the Endourological Society" (CROES) showed that the overall complication rate was 20.5%. Some reports have indicated as high as 83% complication rate. (Vishwajeet Singh et al., 2024)

Serious illnesses like urosepsis and septic shock were found in 0.3-9.3% of patients with complications of fever. Severe sepsis was described as having a source of infection with systemic inflammatory response syndrome (SIRS) during the International Sepsis Definition Conference in 2001.

Patients are assessed for SIRS if they have three of the following:

White blood cell count more than 12,000 per cubic millimeter or less than 4,000 per cubic millimeter, heart rate over 90 beats per minute, respiratory rate over 20 breaths per minute or less than 4000 PaCO2 (partial pressure of carbon dioxide) or body temperature greater than 38C or less than 36C.

Most of the fevers are mild and can be treated alone after a PCNL procedure. The problem associated with PCNL fever is however, bacteremia and urinary extravasation may develop into septicemia and septic shock, which in turn, will lead to morbidity and mortality. (Bannakij Lojanapiwat et al.,2016)

compared with extracorporeal shock wave lithotripsy, and retrograde ureteral flexible lithotripsy, PCNL is still the most invasive and complicated procedure for treating upper urinary tract stones complications after surgery have not been clarified, and the predictive value of some factors is controversial. (Guiming Zhou et al., 2022)

The infection following the procedure following PCNL can cause complications which require extended hospital stays and additional antibiotics treatment. In large series, sepsis was found to be the most frequent cause of perioperative mortality following PCNL. It used to be necessary to have positive blood cultures in order to diagnose sepsis, however it is now known that individuals with sepsis frequently have negative blood cultures. (Omar koras et al., 2015)

The prevalence rate has increased in the USA from 3.8% in the 1970s to 8.8% in the 2000s. Of the different types of uroliths discovered, the staghorn calculi and large renal calculi are important.

These two forms of calculi may cause the impairment to renal function. In various trials, a mortality rate of 30 days of 0.3% was seen. Most of the deaths were due to surgery septicemia. (Tian yang et al., 2017)

The E-PASS score method was used to assess surgical risk of postoperative complications. This scoring system was developed by Haga et al., 2004 and is applicable to PCNL and comprises of Preoperative Risk Score (PRS), Surgical Stress Score (SSS), and Comprehensive Risk Score (CRS). (Mucahit Gelmis et al.,2025)

This technique is important because 69.6% of the European urologists perform percutaneous procedures, and the average number of PNL procedures performed per month is 16.8.

Ultrasound renal scanning and PNL are performed more commonly outside of Europe, presumably because of greater stone loads of the affected patients. (Maurice Stephan Michel et al.,2006)

Postoperative infections are a potential complication of PCNL, and may require extended hospital stays and additional antibiotic treatment. Sepsis was found to be the most common cause of perioperative death in large series of PCNL. Previously, the presence of positive blood cultures was required for the diagnosis of sepsis but it is now recognised that people with sepsis often have negative blood cultures. (Omar koras et al., 2015)

About 12% of Indians suffer from urinary stones, and 50% of them typically have end-stage renal disease. The management of symptomatic kidney stones has undergone a dramatic transformation in the past three decades, from open surgical lithotomy to endourological techniques.Treatment of kidney stones in both children and adults has undergone a dramatic change in the last 30 years, from open surgical lithotomy to minimally invasive endourological methods.

Treatment options for renal stone include three most popular ones: percutaneous nephrolithotomy (PCNL), rigid or flexible retrograde uretroscopic stone fragmentation and retrieval, and extracorporeal shock wave lithotripsy (ESWL). (Udham Singh et al.,2024)

Staghorn calculi come in two forms – partial and complete. Complete staghorn calculi occupy over 80% of the collecting system and grow into the renal pelvis and calyceal branches whereas partial staghorn stones remain in the renal pelvis and in two or more calyces.

The current guidelines recommend percutaneous nephrolithotomy (PCNL) as the best treatment option for staghorn and large volume stones. (Zafar Ahamad khan et al., 2025)

Various types of uroliths have been discovered, but the staghorn calculi and large renal calculi are clinically significant. These two types of calculi can result in a decrease in renal function. A 30-day PCNL mortality rate of 0.3% was found in multiple trials. Most deaths were due to septicemia subsequent to surgery. (Tian yang et al., 2017)

According to the data from the Clinical Research Office of the Endourological Society (CROES), the stone-free rate (SFR) for PCNL for staghorn calculi was 3036 (56.9%) and 4401 (82.5%) for non-staghorn calculi. (Z.A khan et al., 2025)

Following PCNL, most of the fevers will be mild and can be treated separately. PCNL fever can be a concern, however, since it can lead to septicemia and septic shock, increasing the morbidity and mortality risks. (B Lojanapiwat et al.,2016)

The management of symptomatic kidney stones has undergone a dramatic transformation in the past 30 years in both the adult and pediatric population from open surgical lithotomy to minimally invasive endourological procedures. The three most common modae used for treatment of renal stones are extracorporeal shock wave lithotripsy (ESWL), rigid or flexible retrograde uretroscopic stone fragmentation and retrieval, and percutaneous nephrolithotomy (PCNL). (Udham Singh et al.,2024)

The conventional PCNL tract size is 30 Fr, while the mini-PCNL tract size is 14–22 Fr. Despite a good stone clearance, there were complications, including bleeding, due to the introduction of excellent optics, and advances in stone fragmentation, the size of the stones in the tract

has decreased, which has helped to reduce complications without affecting the stone clearance.

One of the consequences related to using the access might be damage to the pleura and other visceral organs. Other complications are incomplete stone clearance, bleeding, discomfort, and infection. (RAH Sharif et al.,2023)

The majority of the effects that occur after PCNL are less severe. Some minor complaints are fever and leakage of urine. As demonstrated, complications are drastically reduced with experience, and stone access/retrieval may lead to serious complications that all urologists must know about. (RAH Sharif et al.,2023)

In PCNL the bull's eye procedure is a technique used to gain access to the kidney using fluoroscopy imaging. It entails matching the needle with the target calyx under fluoroscopic imaging, creating a "bull's eye" image. Needle is moved in a straight line towards the stone thereby decreasing deviation.

This will increase accuracy and minimize issues. It is notably effective for acquiring an optimum percutaneous tract to the kidney stone. (Murad Ali khan et al., 2024)

RATIONALE OF STUDY

Even after Percutaneous Nephrolithotomy (PCNL) is a procedure that requires direct intervention in the renal collecting system, this is a risk for postoperative infectious complications, particularly related to the infected stone. These are important complications to learn, as they will help identify high-risk patients and optimize perioperative antibiotic strategies. Determination of the risk factors and incidence of these infections is critical to bettering the perioperative care and outcomes.

HYPOTHESIS

Alternative Hypothesis (H_1)

Patients who undergo percutaneous nephrolithotomy (PCNL) develop postoperative infectious issues and there is a strong association between postoperative infectious issues and known risk factors.

Null Hypothesis (H_0)

No infective complications are noted after Percutaneous Nephrolithotomy and identified risk factors have no association with post-operative infective complications.

OPERATIONAL DEFINATIONS

Percutaneous Nephrolithotomy:

Percutaneous Nephrolithotomy (PCNL), a minimally invasive surgical procedure, wherein a small cut is made in the back to pass a surgical tract directly into the renal collecting system with the aim of removing large or complex kidney stones.

Postoperative infective complications of PCNL:

Infective complications after surgery are called postoperative infective complications and they are caused by the presence of bacteria after the surgery, mainly after Percutaneous Nephrolithotomy (PNL). They can develop after the surgery, such as urinary tract infection, systemic inflammatory response syndrome (SIRS) and sepsis, due to possible manipulation of the urinary tract and fragmentation of the stone during surgery.

2. LITERATURE REVIEW

They conducted an observational study to investigate the infective consequences after percutaneous nephrolithotomy (PCNL). The most frequent infective complications after PCNL were fever, urinary tract infection (UTI), pyelonephritis and sepsis, the authors wrote. Furthermore, they discovered that patients with a history of preoperative UTI, previous renal surgery, high stone burden, long procedure (>90 minutes) and residual stone fragments had a significantly higher risk of postoperative infections. The study emphasized the importance of comprehensive pre-operative assessment, infection prevention and reducing operating times to reduce the risk of infection and improve surgical outcomes. Actual Investigators: G. Manoj Kumar et al.

Mazhar Ali et al. evaluated outcome of percutaneous nephrolithotomy (PCNL) in urolithiasis patients in tertiary care hospital in southern Punjab, Pakistan. Overall, the study showed a high stone clearance rate of 80.45% and low complication rate (less than 2%) of PCNL,

making it a safe and effective procedure. Hydrothorax was the most common sequelae following upper pole puncture whereas lower pole puncture was associated with higher stone clearance. Additionally, the scientists discovered that patients with staghorn calculi, bigger stones (>3–4 cm), and comorbidities were more likely to experience difficulties and have residual stones.

In addition, the median operating time of only sixty minutes proved the significance of the surgical skill in achieving good clinical outcomes. The study highlighted the importance of tailored treatment approaches and optimizing surgical technique to enhance the success of PCNL in the local population.

Udham Singh et al. (2024) reported that no postoperative mortality occurred and most problems encountered with PCNL were minor (Clavien grades I–II). Fewer than 3% of the cases were complicated. Female sex, hydronephrosis, recent UTI, longer surgical time (>91 minutes), higher Guy's Stone Score (III–IV), multiple calyceal stones and multiple punctations were found to be significant predictors for postoperative problems. The most common problems in the early postoperative period were hematuria, and the most common intra-operative complication was bleeding.

Even though there have been improvements in minimally invasive surgery, post-operative infection is still one of the most severe complications, Bannakij Lojanapiwat noted. Although septic shock is a rare condition, the author emphasized that it is a condition associated with a high mortality rate and should be diagnosed and treated promptly. The role of intra-operative urine and stone cultures in detecting the microorganisms present in the urine and guiding appropriate antibiotic therapy in the postoperative period was also highlighted.

Additionally, adherence to standardized PCNL procedures and proper antibiotic prophylaxis were suggested as crucial tactics to lower postoperative infectious problems and enhance patient outcomes.

Guiming Zhou, et al., performed a comprehensive review and meta-analysis to determine independent risk factors for infectious complications after percutaneous nephrolithotomy (PCNL). They found that there was a definite association between microbiological features and an increased risk of postoperative infection; they included positive preoperative urine culture, positive renal pelvic urine culture, positive stone culture, urine leukocytosis and infected stones.

Furthermore, higher inflammatory indicators such as the neutrophil-to-lymphocyte ratio (NLR) and peripheral blood leukocyte count were found to be important predictors of the onset of infection. The authors also found that patients who undergo stenting prior to surgery may have higher infection risks in certain patients.

The authors concluded that using microbiological testing and inflammatory markers in the preoperative evaluation to direct an antibiotic regimen at the time of surgery to reduce the incidence of infectious complications after PCNL.

Omer Koras and colleagues conducted a prospective clinical trial to evaluate the risk factors of infection complication pre- and intraoperatively, following percutaneous nephrolithotomy (PCNL). The results of the study showed that 27.4% of patients developed systemic inflammatory response syndrome (SIRS) and 7.6% developed sepsis. Escherichia coli, Pseudomonas aeruginosa, Enterococcus, and Klebsiellas pecies were among the frequently found pathogens. The development of SIRS and sepsis was found to be significantly predicted by infected stones, a greater stone burden (≥800 mm^2), and a history of recurrent UTIs.

The results highlight the importance of performing the procedure with careful pre-operative risk assessment and evaluation of the risk of infection to reduce the potential for post-PCNL significant infectious complications.

Tian Yang et al. created a prediction model for the early detection of problems and an analysis of risk factors for postoperative infectious complications following percutaneous nephrolithotomy (PCNL). The study revealed that a total of 12.2% of patients had a fever after surgery, and 27.4% of patients had systemic inflammatory response syndrome (SIRS). Multivariate analysis showed larger stones and increased urine white blood cell (WBC)

counts to be significant predictors of both SIRS and fever.

In addition, there was a correlation between albumin level and the rate of postoperative fever, indicating that better nutritional status may prevent postoperative fever. The authors concluded that clinical and laboratory parameters, especially the stone burden and the urinary infection markers, could improve the risk assessment for the PCNL and provide a better orientation for the preventive care programs for patients undergoing this procedure.

Mucahit Gelmis et al. assessed the predictive value of Estimation of Physiologic Ability and Surgical Stress (E-PASS) score for postoperative complications after conventional percutaneous nephrolithotomy (PCNL) procedure in kidney stone patients who were greater than 2 cm in size. 17.4% of patients in this retrospective analysis experienced postoperative problems, which were categorized using the modified Clavien-Dindo method.

They identified the presence of comorbid diseases (diabetes mellitus and coronary artery disease) and advanced age and higher American Society of Anesthesiologists (ASA) scores as significant risk factors for poor outcomes.

In addition, factors seen at operation included were longer operating times, greater number of operating access tracts, and greater blood loss associated with higher complication rates. Multivariate analysis identified higher stone burden, as well as higher Comprehensive Risk Score (CRS) as an independent predictor of postoperative complications.

The study results suggest that the E-PASS score system is a useful tool for determining the risk in PCNL and may be useful in selecting patients and planning them perioperatively.

In a single-center prospective study, Udham Singh et al. evaluated complications and the risk factors associated with percutaneous nephrolithotomy (PCNL). A total of 21.9% of complications were recorded by the authors, with the majority being minor (Clavien grade I–II) and a lesser percentage being significant (Clavien ≥III). There were no fatalities reported. They discovered that though hematuria was commonly observed in the early postoperative period, bleeding was the commonest intra-operative complication. Multiple calyceal involvement, presence of hydronephrosis, recent UTIs, larger stone burden (>3 cm), longer operating times, female gender, Guy's Stone Score (III-IV) and multiple access punctures were all found to be significant multivariate predictors of increased risk of complications.

The study identified that proper patient selection and the optimization of the operating strategy will have a major impact on minimizing the complication rate and improving the overall outcome of the PCNL.

Hemorrhage and collecting system injury were the most frequently seen complications during the procedure with mini-PCNL in staghorn stone patients, 18.3% of the time, according to the study. Postoperative complications included fever/infection (79%), urosepsis (36%), delayed bleeding (16%) and a low death rate (0.8%). The authors noted that some of the patients required further stone clearance treatments even when treated with least invasive techniques, thus emphasizing the challenge of treating staghorn stones, even with the least invasive methods.

The outcomes overall reflect that management of infection and peri-operative optimization remain important in minimizing adverse outcomes in complex stone disease despite the positive safety profile of mini-PCNL.

Koras et al. (2014) carried out a prospective clinical study with 303 patients having percutaneous nephrolithotomy (PCNL). Patients were assessed by pre-operative urine cultures, renal pelvic urine culture and stone culture. Following surgery, the development of sepsis and systemic inflammatory response syndrome (SIRS) was tracked.

The study revealed 7.6% patients developed sepsis after PCNL and 27.4% developed SIRS. Escherichia coli was the most usually isolated bacteria, followed by Pseudomonas aeruginosa Enterococcus, and Klebsiella species. Multivariate analysis revealed that infection stones, stone burden ≥ 800 mm^2, and recurrent UTIs were independently associated with SIRS and sepsis.

As a result of this the authors decided that recognizing these risk factors during the

preoperative evaluation can help to identify patients that are at high risk and guide the direction of measures to prevent them from developing postoperative infectious complications after PCNL (Koras et al., 2014).

Yadav et al. (2018) studied the relationship between the urine culture before and complications after percutaneous nephrolithotomy (PCNL). This comparative study of 136 patients found that postoperative infectious complications occurred significantly more often in patients who had a positive urine culture prior to surgery (54.9%) vs. those who had a negative urine culture before surgery (23.5%). Interestingly, even culture-positive patients who had sterile urine prior to surgery had an increased risk. Escherichia coli was the most common and amikacin sensitive organism. The study also revealed that there were no differences between the two groups in terms of operating time, blood transfusion rate or length of hospital stay, although there was one death in the culture-positive group.

The authors concluded that positive urine culture history remains a strong risk factor for postoperative complications, reinforcing the need for good perioperative monitoring in patients with positive urine culture history.

3. AIM AND OBJECTIVE

1. To evaluate the postoperative infective complication of PCNL.

4.MATERIAL AND METHODS

4.1 Study design:

The study design was observational cross-sectional study.

4.2 Setting:

Mayo hospital Lahore.

4.3 Study duration:

The study was conducted over a period of four months.

4.4 Sample size:

78 patient made up the sample size

4.5 Sampling technique:

Sampling was done using a purposive sampling technique.

4.6 Selection of the sample:

All individual undergo PCNL are eligible to participate.

4.7 Inclusion criteria:

- All individual above 18 age are included.
- patient undergo PCNL

4.8 Exclusion criteria:

- Patient with preoperative fever or positive urine culture were not taken
- Patient not willing to give consent

4.9 Ethical consideration:

During research exclusion we closely adhere to ethical protocol defined by the university of Lahore ethical committee and protected our research participants right. The entire data collection procedure and information storage was kept confidential. All participants were aware of no adverse effect of research procedure. Participants understood their freedom to leave the study at any stage of research process. This study found that there was no previously known safety concern with the exclusion. The research participant is not rewarded with anything for his or her participation in the research as outlined by the ethical committee of the university of Lahore. During the course of the study, we took all precautions to protect your personal information and to respect the right to information of the research participant.

4.10 Data collection procedure:

This study uses data from Mayo hospital. To determine the post operative complications in patients who had PCNL. A standardized questionnaire was used by the researcher. The target population was aged over 18 y. Data collection process had been documented, contrasted and analysed.

4.11 Data Analysis procedure:

Data analysis was done with SPSS version 27. It was studied statistically, e.g. by frequency analysis,

and the results of the necessary outcome will be presented in tables.

5. RESULTS

Table 1. Demographic Factor:

Variable	Mean	SD
Age	48.1	12.2

The was 48.1 years, with a 12.2-year standard deviation. This suggests that the majority of the patients were middle-aged, with most being between the ages of 36 and 60. The age distribution points to a fairly diverse group that includes both younger and older adults, but is primarily focused on the fifth decade of life

Table 2. Demographic factor:

Variable	Number of cases (%)
Male	60 (76.9)
Female	18 (23.1)
Right	44 (56.4)
Left	34 (43.6)

I examined 78 patients in total. Men made up 60 cases (76.9%) of the sample, while women made up only 18 cases (23.1%). Upon examining the lesion's laterality, we discovered that 34 patients (43.6%) had it on their left side and 44 patients (56.4%) had it on their right.

Table 3. Variables:

Variable	**Number of cases** (%)
Flank pain	74 (94.9)
DM	19 (24.4)
HTN	26 (33.3)
History of UTI	5 (6.4)
History of urosepsis	2 (2.6)
Preoperative stenting	15 (19.2)
Nephrostomy	0 (0)
Past history of Surgery	27 (34.6)
Staghorn	23 (29.5)
Multiple	22 (28.2)
Uppercalyx	7 (9.0)
Ureter	7 (9.0)
Hydronephrosis	47 (60.3)
DJS	75 (96.2)
Nephrostomy	61 (78.2)
Puncture - one	67 (85.9)
More than one puncture	11 (14.1)
Tract size <22 Fr	39 (50.0)
Tract size >22 Fr	39 (50.0)
Duration <90 MTS	45 (57.7)
Duration >90 MTS	33 (42.3)

Residual calculi present	10 (12.8)

This analysis included a total of 78 patients. Flank pain was the most frequently reported presenting symptom, occurring in 74 patients (94.9%). In terms of chronic conditions, 26 patients (33.3%) had hypertension (HTN), and 19 patients (24.4%) had diabetes mellitus (DM). Five patients (6.4%) had a history of UTI, whereas only two patients (2.6%) had a history of urosepsis. 34.6 percent of patients had undergone previous urological or other surgical procedures. Regarding the characteristics of the stones, 23 patients (29.5%) had staghorn calculi, and 22 patients (28.2%) had multiple stones. Seven patients (9.0%) had ureteric or upper calyx stones. 15 patients (or 19.2%) underwent preoperative stenting, and no patient required a preoperative nephrostomy.

Table 4. Outcomes:

Outcome	Frequency (%)
Fever	28 (35.9)
UTI	17 (21.8)
Pyelonephritis	5 (6.4)
Sepsis	4 (5.1)

Postoperative complications were tracked and documented among the 78 patients. Fever was the most common outcome, occurring in 28 patients (35.9%). In 17 patients (21.8%), a urinary tract infection (UTI) was reported. Severe infectious complications were less common: four patients (5.1%) had sepsis, and five patients (6.4%) developed pyelonephritis. Overall, a significant percentage of the cohort experienced infectious complications of varying degrees of severity, with fever being the most common symptom.

Table 5. Association between outcome and variable:

	Fever		
	Yes (n=28), n (%)	**No (n=50), n (%)**	P value
Male	23 (38.3)	37 (61.7)	0.402
Female	5 (27.8)	13 (72.2)	
Right	18 (40.9)	26 (59.1)	0.197
Left	10 (29.4)	24 (70.6)	
<22	11 (28.2)	28 (71.8)	0.156
>22	17 (43.6)	22 (56.4)	
<90	10 (22.2)	35 (77.8)	**0.006**
>90	18 (54.5)	15 (45.5)	
One puncture	22 (32.8)	45 (67.2)	0.142
>1 puncture	6 (54.5)	5 (45.5)	
DM	8 (42.1)	11 (57.9)	0.446
HTN	12 (46.2)	14 (53.8)	0.149
UTI	6 (66.7)	3 (33.3)	**0.000**
Urosepsis	2 (100)	0 (0)	**0.005**
Stenting	7 (46.7)	8 (53.3)	0.419
History of surgery	14 (51.9)	13 (48.1)	**0.041**
Staghorn	11 (47.8)	12 (52.2)	0.160
Multiple	6 (27.3)	16 (72.7)	0.420
Uppercalyx	1 (14.3)	6 (85.7)	0.423

Ureter	2 (28.6)	5 (71.4)	0.535
Hydronephrosis	16 (34.0)	31 (66.0)	0.829
DJS	27 (36.0)	48 (64.0)	0.892
Nephrostomy	22 (36.1)	39 (63.9)	0.921
Residual calculi	8 (80.0)	2 (20.0)	**0.006**

A comparison of 78 patients showed that 28 cases (35.9%) had postoperative fever, which was strongly correlated with a number of variables. Fever was significantly associated with longer surgical times than 90 minutes, affecting 54.5% of these patients as opposed to only 22.2% of those with shorter procedures (p=0.006). Additionally, there was a significant correlation between the presence of residual calculi and fever, with 80% of these patients experiencing fever compared to 20% without residual stones (p=0.006). Prior urosepsis and a history of UTIs were both highly predictive, with fever rates of 100% and 66.7%, respectively (p=0.000 and p=0.005). Furthermore, the fever rate was significantly higher (51.9%) in patients with a prior surgical history than in those without (p=0.041).

There was no discernible correlation between the development of fever and other factors like gender, side of surgery, tract size, number of punctures, comorbidities, stone characteristics, and use of stents or nephrostomies. The main risk factors for postoperative fever in this cohort were found to be prolonged surgery, residual stones, and a history of urinary infections or previous surgeries.

Table 6. Association between outcome and variable: UTI

	Yes (n=17), n (%)	**No (n=61), n (%)**	P value
Male	14 (23.3)	46 (76.7)	0.383
Female	3 (16.7)	15 (83.3)	
Right	11 (25.0)	33 (75.0)	0.174
Left	6 (17.6)	28 (82.4)	
<22	6 (15.4)	33 (84.6)	0.263
>22	11 (28.2)	28 (71.8)	
<90	5 (11.1)	40 (88.9)	**0.008**
>90	12 (36.4)	21 (63.6)	
One puncture	13 (19.4)	54 (80.6)	0.196
>1 puncture	4 (36.4)	7 (63.6)	
DM	4 (21.1)	15 (78.9)	0.873
HTN	7 (26.9)	19 (73.1)	0.355
UTI	2 (40.0)	3 (60.0)	0.123
Urosepsis	1 (50.0)	1 (50.0)	**0.014**
Stenting	3 (20.0)	12 (80.0)	0.912
History of surgery	9 (33.3)	18 (66.7)	0.079
Staghorn	7 (30.4)	16 (69.6)	0.153
Multiple	3 (13.6)	19 (86.4)	0.352
Uppercalyx	0 (0)	7 (100)	0.147
Ureter	1 (14.3)	6 (85.7)	0.853
Hydronephrosis	11 (23.4)	36 (76.6)	0.518
DJS	17 (22.7)	58 (77.3)	0.394

Nephrostomy	14 (23.0)	47 (77.0)	0.402
Residual calculi	6 (60.0)	4 (40.0)	**0.006**

17 out of 78 patients experienced postoperative urinary tract infections, according to a closer examination. Once more, the length of the procedure was a significant factor; infections happened in 36.4% of cases where the procedure took longer than 90 minutes, compared to just 11.1% in shorter surgeries (p=0.008). The development of UTIs was also significantly correlated with the presence of residual calculi, which affected 60% of patients with leftover fragments compared to only 40% of those without (p=0.006). There was also a significant correlation with a history of urosepsis, with 50% of these patients developing a UTI (p=0.014).

None of these factors reached statistical significance, although infection rates were somewhat higher in males, right-sided procedures, larger tract sizes, multiple punctures, and a prior surgical history. The occurrence of UTIs did not seem to be significantly correlated with other factors such as diabetes, hypertension, previous UTI history, stone characteristics, hydronephrosis, or the use of stents or nephrostomy tubes. The most significant predictors of postoperative urinary tract infection int group were found to be prolonged surgical time residual stone fragment and a previous episode of urosepsis.

Table 7. Association between outcome and variable: Pyelonephritis

	Yes (n=5), n (%)	No (n=73), n (%)	
Male	3 (5.0)	57 (95.0)	0.521
Female	2 (11.1)	16 (88.9)	
Right	2 (4.5)	42 (95.5)	0.754
Left	3 (8.8)	31 (91.2)	
<22	1 (2.6)	38 (97.4)	0.421
>22	4 (10.3)	35 (89.7)	
<90	1 (2.2)	44 (97.8)	0.250
>90	4 (12.1)	29 (87.9)	
One puncture	4 (6.0)	63 (94.0)	0.878
>1 puncture	1 (9.1)	10 (90.9)	
DM	2 (10.5)	17 (89.5)	0.177
HTN	2 (7.7)	24 (92.3)	0.417
UTI	3 (60.0)	2 (40.0)	**0.000**
Urosepsis	1 (50.0)	1 (50.0)	**0.001**
Stenting	1 (6.7)	14 (93.3)	0.850
History of surgery	2 (7.4)	25 (92.6)	0.952
Staghorn	3 (13.0)	20 (87.0)	**0.048**
Multiple	0 (0)	22 (100)	0.139
Uppercalyx	0 (0)	7 (100)	0.466
Ureter	0 (0)	7 (100)	0.480
Hydronephrosis	3 (6.4)	44 (93.6)	0.761
DJS	5 (6.7)	70 (93.3)	0.673
Nephrostomy	4 (6.6)	57 (93.4)	0.786
Residual calculi	2 (20.0)	8 (80.0)	0.158

Only five of the 78 patients experienced postoperative pyelonephritis, making it a comparatively rare complication. The most notable finding was the strong correlation with a history of UTIs: 60% of patients who had previously had a UTI developed pyelonephritis, compared to only 40% of those who did not (p=0.000). Similarly, 50% of these cases had a history of urosepsis, which was also significantly correlated (p=0.001). 13% of patients with staghorn calculi developed pyelonephritis compared to 87% who did not (p=0.048), indicating a weak correlation. Male gender, larger tract sizes, and longer operating times all appeared to have slightly higher rates, but none of these were statistically significant.

The use of stents or nephrostomy tubes, hydronephrosis, multiple or upper calyceal stones, diabetes, and hypertension did not demonstrate any significant correlation. Remarkably, 20% of pyelonephritis cases had residual calculi, although this result was not statistically significant. The most significant predictors were essentially a history of urosepsis or urinary infection; other clinical and procedural factors seemed to have less of an impact on the development of pyelonephritis .

Table 8. Association between outcome between outcome and variable: sepsis

	Yes (n=4), n (%)	No (n=74), n (%)	
Male	3 (5.0)	57 (95.0)	0.922
Female	1 (5.6)	17 (94.4)	
Right	2 (4.5)	42 (95.5)	0.450
Left	2 (5.9)	32 (94.1)	
<22	1 (2.6)	38 (97.4)	0.662
>22	3 (7.7)	36 (92.3)	
<90	1 (2.2)	44 (97.8)	0.101
>90	3 (9.1)	30 (90.9)	
One puncture	3 (4.5)	64 (95.5)	0.721
>1 puncture	1 (9.1)	10 (90.9)	
DM	2 (10.5)	17 (89.5)	0.080
HTN	2 (7.7)	24 (92.3)	0.223
UTI	2 (40.0)	3 (60.0)	**0.003**
Urosepsis	1 (50.0)	1 (50.0)	**0.000**
Stenting	0 (0)	15 (100)	0.275
History of surgery	1 (3.7)	26 (96.3)	0.495
Staghorn	2 (8.7)	21 (91.3)	0.134
Multiple	1 (4.5)	21 (95.5)	0.709
Uppercalyx	0 (0)	7 (100)	0.504
Ureter	0 (0)	7 (100)	0.520
Hydronephrosis	2 (4.3)	45 (95.7)	1.000
DJS	4 (5.3)	71 (94.7)	0.694
Nephrostomy	4 (6.6)	57 (93.4)	0.248
Residual calculi	1 (10.0)	9 (90.0)	0.661

Only 4 out of 78 patients in this series experienced postoperative sepsis, making it an uncommon occurrence. The most significant correlations were found between a history of urosepsis and urinary tract infection: 50% of patients with a history of urosepsis went on to develop this complication (p=0.000), while 40% of patients with a prior UTI developed sepsis compared to 60% who did not (p=0.003). While sepsis rates were slightly higher in patients with diabetes, longer operating times

(greater than 90 minutes), larger tract sizes, and multiple punctures, none of these differences were statistically significant. It's interesting to note that patients with stones in the ureter or upper calyx, as well as those who had preoperative stenting, did not experience any sepsis. There was no significant correlation found between the development of sepsis and other factors such as gender, side of surgery, hypertension, stone type, hydronephrosis, nephrostomy placement, or residual calculi. Overall, the most significant predictors were a positive history of urosepsis or urinary infection; the majority of other clinical and procedural factors seemed to have little bearing on the incidence of sepsis.

6. DISCUSSION

Because of its high stone-free rate and minimally invasive technique, percutaneous nephrolithotomy (PCNL) is regarded as the gold standard surgical therapy for the treatment of big and complex renal calculi. Despite its efficacy, postoperative infectious complications continue to be a significant worry since they are linked to longer hospital stays, higher medical expenses, and, in extreme situations, potentially fatal sepsis. In order to determine the patient-related, stone-related, and procedure-related factors linked to these issues among 78 patients, the current study was carried out to assess the frequency of postoperative infectious complications after PCNL.

The majority of patients in this study were middle aged and male. The mean age in the present study was 47.7 years with males forming 77.9% of the study population, which is in conformity to the results obtained by Kumar et al. (2021). Men have consistently been found to be at increased risk of renal stones, possibly due to dietary factors, occupational dehydration, hormonal differences and metabolic factors. Despite the increasing incidence of nephrolithiasis among women over the last few years, males still outnumber females in numbers for PCNL.

Flank pain was most frequently reported symptom in the present study. Almost all the patients preoperatively reported flank pain which is expected because renal calculi can cause urine flow blockage and straining of the renal capsule. Similarly, Kumar et al(2021). reported flank pain in approximately 95% of patients, making pain the most common clinical symptom of those requiring PCNL.

Two of the most common comorbidities were found to be diabetes mellitus and hypertension. Diabetes is a major risk for postoperative infection due to its effects of decreasing the immune system, neutrophil activity, and promoting bacterial growth. However, while both diabetes and UTI were present in the study group, diabetes was not determined to be a statistically significant independent predictor of either UTI or postoperative fever. This finding is similar to that of the parent study, in which the prevalence of diabetes was approximately 25%, and diabetes was not significantly correlated with postoperative fever or UTI.

A few patients had a history of urinary tract infection before surgery. These patients showed a higher risk of developing postoperative infectious problems, even after effective therapy and documentation of sterile urine cultures before to PCNL. This is similar to the results obtained by Kumar et al(2021) which showed that urosepsis and urinary tract infection (UTI) significantly increased the risk of sepsis, postoperative fever and UTI. Even when urine cultures are negative, viable bacteria that remain in stones (or collecting system) might not have been detected and become clinical when released after stone breakdown.

Postoperative results were also impacted by stone properties. In the subjects some kidney stones and staghorn calculi were not uncommon. Postoperative pyelonephritis was more common in patients with staghorn stones than in those without. The results obtained are similar to that obtained by Kumar et al(2021) who demonstrated statistically significant association between staghorn calculi and postoperative pyelonephritis. The bacteria spread during surgery is increased due to the contaminated material in the staghorn and the requirement to manipulate it for a longer time.

Hydronephrosis was a common radiological finding in the subjects of the study. Nevertheless, hydronephrosis by itself did not seem to

considerably raise the risk of infectious problems following surgery, much like in the parent study. Hydronephrosis is associated with urinary obstruction, but can be minimized with careful preoperative decompression, antibiotic prophylaxis and management during surgery.

In this investigation, too, the operative parameters which may result in infection after a PCNL were evaluated. Once patients were able to get access to a single tract, most received a double-J stent. The same surgical techniques were reported in the parent paper. There was no significant correlation between the number of punctures and the postoperative infective problems, nor between tract size and the number of punctures. This suggests that the risk for infection can be minimized by skillful surgical technique and careful intraoperative management, irrespective of tract size.

Determining the frequency of postoperative infectious complications among patients having percutaneous nephrolithotomy (PCNL) and identifying the patient-, stone-, and procedure-related characteristics associated with these complications were the main goals of the current investigation. This study showed that the most common infectious complication was postoperative fever, followed by sepsis, pyelonephritis and urinary tract infection (UTI). The results obtained are comparable to those obtained by Kumar et al. (2021), who found that out of 18.9% of patients who had postoperative fever, 11.1% had UTI, 3.2% had pyelonephritis and 2.6% had sepsis. The findings' similarities imply that, despite advancements in surgical methods and perioperative care, postoperative infectious problems continue to be a major therapeutic issue.

The most common complication in this study was postoperative fever. Post-PCNL fever is usually caused by the high intrarenal pressure during surgery or bacteria translocating into the blood stream during the process of manipulating contaminated stones. While often self-limiting, fever can be the first indication of a more serious step of the infectious process. The present findings are consistent with the parent study that revealed fever to be the most common infectious complication after surgery. In a similar study, de la Rosette and colleagues found that in the world, fever is one of the most frequent complications after PCNL. These results highlight the significance of meticulous postoperative monitoring in order to start early antibiotic medication and supportive care if needed.

Additionally, the current research's incidence of postoperative UTIs was similar to that of the parent study. A percentage of patients experienced postoperative UTI even though all patients had the proper preoperative evaluation and those with positive urine cultures got culture-directed antibiotic medication prior to surgery. The idea that sterile preoperative urine cultures do not totally remove the risk of postoperative infection is supported by this finding. Although urine cultures might not detect bacteria trapped within renal stones or renal collecting system, bacteria may be released during stone fragmentation and lead to infection after surgery. Similar results were reported by Kumar et al(2021)., who came to the conclusion that a prior urinary tract infection greatly raised the risk of infectious complications following surgery.

In this study, a very small number of people got pyelonephritis. Pyelonephritis is still clinically significant despite its comparatively low incidence since an untreated infection can quickly lead to sepsis and multiple organ failure. The present findings revealed the higher incidence of postoperative pyelonephritis in patients having staghorn calculi. The results of the present study are in agreement with the findings of Kumar et al (2021) that showed that the presence of staghorn stones was a statistically significant risk factor for postoperative pyelonephritis. The staghorn calculi tend to be composed of disorganized material and also occupy a large portion of the collecting system, requiring extensive surgical manipulation. Their higher correlation with postoperative infection can be explained by these traits.

Sepsis was the least common but most severe postoperative infection in the present study. Despite sepsis having been a very small proportion of people, it is a complication that must be picked up very early as it is associated with high morbidity and mortality. These findings are similar to the

parent study, which revealed that the primary cause of death following PCNL was still postoperative sepsis with a 2.6% sepsis rate. Early identification of the high-risk patient, prompt broad-spectrum antibiotic treatment, aggressive fluid resuscitation and monitoring remain important to improve patient outcomes.

The duration of the procedure was one of the most important procedure related variables that correlated to postoperative infection. Patients who had surgeries longer than 90 minutes were more likely to develop UTIs and postoperative fever than those who had shorter surgeries. This finding is similar to the one of Kumar et al(2021) that found statistically significant correlation between urinary tract infection and an operation of a duration more than 90 minutes and postoperative fever. Longer operating periods may result in increased intrarenal pressure, more manipulation of the tissue, more spread of bacteria and more absorption of contaminated irrigation fluid into the systemic circulation.

Residual stones was another important factor to be associated with infectious complications after surgery. Stone size had no impact on the incidence of postoperative fever or UTIs, while stone size had a significant impact in the presence of stone remnants. The incidence of postoperative fever or UTIs was higher in the stone remnant group than in those with complete stone removal. This finding is consistent with the parent study, which showed a significant correlation between postoperative fever and UTI and presence of a stone. Surgery can often leave small fragments with bacteria which act as an ongoing source of infection. Therefore, when it is safe to do so, attaining maximum stone clearance during the initial treatment continues to be a key goal of PCNL.

In this study, the effects of previous kidney surgery on the occurrence of infectious complications after surgery were also evaluated. Patients who had had a previous renal surgery had more postoperative fevers than those who had not had renal surgery before. Similar findings were observed by Kumar et al(2021) where they found that there was a significant increase in the risk of postoperative fever in those who had undergone kidney surgery prior to the surgery. Fibrosis, changed renal anatomy, and technical challenges during PCNL can result from prior surgical intervention, lengthening the procedure and causing tissue damage.

Overall, the results of this study provide credence to the complex nature of postoperative infectious problems following PCNL. Patient-related factors, stone burden, length of surgery and remaining stones all have an effect on the total risk of infection. By becoming aware of these risks before surgery, clinicians can alert patients to their potential risk, and take steps to prevent such complications, including using sufficient antibiotic prophylaxis, careful surgical technique, patient selection, and diligent postoperative monitoring.

The current study's results are mostly in line with earlier national and international investigations that assessed postoperative infectious complications after percutaneous nephrolithotomy (PCNL). Although the surgical techniques, endoscopic instrumentations and peri-operative antibiotic protocols have improved the outcomes of patients undergoing this treatment, postoperative infection continues to be one of the major complications associated with this procedure. The results of the current study further reinforce the importance of a careful selection of patients, thorough preoperative assessment and prudent intra-operative care to reduce postoperative morbidity.

The current study suggests that patients with previous urinary tract infection (UTI) were at higher risk for postoperative infectious complications. This finding corroborates with that of Kumar et al. (2021), who reported a significantly higher rate of patients having experienced urosepsis and urinary tract infections in the past, who also developed sepsis, postoperative fever, and postoperative UTIs after PCNL. Urine cultures can be sterile before surgery and bacteria can remain in infected renal stones or as biofilms in the collecting system. These microbes can be released into the blood following fragmentation of the stone, causing a postoperative infection. Therefore, getting a sterile urine culture prior to surgery should be regarded

as essential but insufficient to completely exclude the possibility of infection problems following surgery.

In the present study, it has been observed that those patients with a history of UTI tended to have infectious problems postoperatively. This is consistent with a study by Kumar et al. (2021) that showed that patients who had a previous history of urosepsis and UTIs were significantly more likely to have developed sepsis, postoperative fever or UTIs after PCNL. Bacteria can also be found in renal stones that are diseased or can form a biofilm within the collecting system, even if the urine culture is sterile prior to surgery. After stone breakage, these microorganisms can go into the bloodstream and lead to post-stone infection. Good perioperative control of blood glucose levels is still essential, as poor glucose regulation could negatively affect wound healing and bacterial proliferation.

Another prevalent comorbidity among research participants was hypertension. Nevertheless, hypertension by itself did not seem to have a substantial impact on postoperative infection outcomes, much like in the parent study. This implies that rather than being a stand-alone risk factor for postoperative infection after PCNL, hypertension is more likely to be a coexisting medical condition.

This study also evaluated some of the technical aspects of a surgical procedure. The number of people requiring more than one puncture during PCNL was small. The number of punctures did not significantly correlate with the infectious problems in the postoperative period, which is similar to the findings of Kumar et al(2021). From this observation, it was concluded that multiple access tracts are not necessarily associated with an increased risk of postoperative infection if performed by experienced surgeons with correct surgical techniques.

In a similar vein, there was no statistically significant correlation seen between tract size and infectious problems following surgery. The results of the present investigation were the same for both small and large diameters of the tracts. The finding was similar by Kumar et al. (2021) who reported that there was no correlation between tract size and the urinary tract infection or postoperative fever. These findings suggest that the size of the tract might not be as important as careful planning and surgical skill when it comes to preventing infections after the surgery.

Another important aspect that emerged from the current study was the high post-surgical placement of Double-J (DJ) stents. Most of the patients were stenting after surgery to relieve urine outflow and reduce the risks of ureteral obstruction. Most of the patients in the original study were treated for DJ with a DJ stent, which is a similar procedure. Although there is a small risk of short-term discomfort from the stents, they are used to facilitate the drainage of urine and can reduce post-operative problems from urinary obstruction.

The study's conclusions have a number of significant clinical ramifications. High risk patients should be identified prior to surgery if the patient has a history of urinary tract infections, prior renal surgery, staghorn calculi, prolonged operating time, and/or residual stone fragments. Close monitoring of surgery, correct antibiotic prophylaxis and careful optimization of these patients before surgery are essential. Second, every effort should be made to minimize the surgical time, while maintaining patient safety. Third, getting as much stone removed as possible during the first procedure may lessen the chance of a recurring infection and the need for additional treatments. Lastly, in order to stop the development of sepsis or pyelonephritis, early detection of postoperative fever and timely microbiological testing are still crucial.

The current study has a number of advantages. It evaluated several patient-related, stone-related and operating-related factors and their association with the development of surgical complications with infections. Moreover, all the patients were treated based on the well-defined protocols that were followed for the perioperative period, thereby minimizing patient care variation. Included in these protocols was urine culture screening prior to surgery and antibiotic prophylaxis. Therefore, the results offer valuable information for enhancing perioperative treatment for PCNL patients.

There are a couple of disadvantages of using a crib, however. A relatively small number of 78 patients could have reduced the statistical strength of the less significant correlations between some variables and the postoperative infection. Moreover, the findings of this study may not be generalizable to other health care settings. The study methodology's observational approach does not allow for causal linkages to be definitively established. Lastly, there was little long-term follow-up following discharge, which may have prevented the identification of some late postoperative infection problems. Higher number of cases are recommended in future multi-centre studies and it should be noted that the present study has limited numbers.

CONCLUSION

The results of this study demonstrate that postoperative infectious complications continue to be a significant problem after percutaneous nephrolithotomy. Fever was the most common complication followed by Sepsis, Pyelonephritis, and Urinary tract infections. The risk factors such as prior urinary tract infection, prior renal surgery, presence of staghorn stones, longer operating time and stone remnants were associated with a higher risk of postoperative infection. The results are consistent with Kumar et al. (2021), and underscore the importance of comprehensive preoperative assessment, careful surgical management, complete stone clearance, if possible, and postoperative monitoring to optimize outcomes.

RECOMMENDATION

- Preoperative urine tests and culture routinely and treat any active UTI prior to PCNL.
- Patients with stones like complicated stones or staghorn stones, those with history of UTI and stone surgery should be monitored closely as they are more prone to infection after surgery.
- Operate for as short a period of time as possible, and clear all stones, when possible.
- Give patients the proper antibiotic prophylaxis and keep a close eye out for any early indications of postoperative infection.
- Conduct larger multicenter studies with longer follow-up to further evaluate risk factors for infectious complications after PCNL.

Limitations

The small number of patients (78) may make it harder to find weaker correlations.
The study was carried out in a single environment, which could have an impact on its generalizability.
The microbiological aspects such as urine culture from the renal pelvis and stone culture were not included.
The long-term follow-up after discharge was not evaluated.
The design of the study is less causal.

REFERENCES

Kumar, G. M., Nirmal, K. P., & Kumar, G. S. (2018). *Postoperative infective complications following percutaneous nephrolithotomy*. Indian Journal of Urology, 34(3), 209–213.

Ali, M., Naeem, Q., Zafar, U., Abbas, A., Muhammad, F., Naqash, M., Ghouri, N., Khan, M. A., & Ali, A. (2024). *Outcomes and complications of percutaneous nephrolithotomy (PCNL): A single-center experience*. Cureus, *16*(5), e59558

Singh, U., Singh, V. K., Singh, V., Singh, A., & Singh, J. (2024). *Complications of percutaneous nephrolithotomy: Experience from a tertiary care center*. Cureus, *16*(9), e69096.

Lojanapiwat, B. (2016). *Infective complications following percutaneous nephrolithotomy*. Urological Science, *27*(1), 8–12.

Zhou, G., Zhou, Y., Chen, R., Wang, D., Zhou, S., Zhong, J., Zhao, Y., Wan, C., Yang, B., Xu, J., Geng, E., Li, G., Huang, Y., Liu, H., & Liu, J. (2023). *The influencing factors of infectious complications after percutaneous nephrolithotomy: A systematic review and meta-analysis*. World Journal of Urology, *41*(3), 657–670.

oras, O., Bozkurt, I. H., Yonguç, T., Değirmenci, T., Arslan, B., Günlüsoy, B., Aydoğdu, Ö., & Minareci, S. (2015). *Risk factors for postoperative infectious complications following percutaneous nephrolithotomy: A prospective clinical study*. Urolithiasis, *43*(1), 55–60.

Yang, T., Liu, S., Hu, J., Wang, L., & Jiang, H. (2017). *The evaluation of risk factors for postoperative infectious complications after percutaneous nephrolithotomy*. BioMed Research International, *2017*, Article 4832051.

Gelmis, M., Bulut, B., Kose, M. G., Gonultas, S., Ayten, A., & Arslan, B. (2025). *Evaluating postoperative complications in standard percutaneous nephrolithotomy for renal stones larger than 2 cm: A retrospective study utilizing the E-PASS scoring system*. *Urolithiasis, 53*(1), 20

Singh, U., Singh, V. K., Singh, V., Singh, A., & Singh, J. (2024). *Complications of percutaneous nephrolithotomy: Experience from a tertiary care center*. *Cureus, 16*(9), e69096.

Koras, O., Bozkurt, I. H., Yonguç, T., Değirmenci, T., Arslan, B., Günlüsoy, B., Aydoğdu, Ö., & Minareci, S. (2015). *Risk factors for postoperative infectious complications following percutaneous nephrolithotomy: A prospective clinical study*. *Urolithiasis, 43*(1), 55–60.

Yadav, B. K., Basnet, R. B., Shrestha, A., & Shrestha, P. M. (2019). *Infective complications after percutaneous nephrolithotomy in relation to preoperative urine culture status*. *Journal of Patan Academy of Health Sciences, 6*(1), 8–13.

Zhou, G., Zhou, Y., Chen, R., Wang, D., Zhou, S., Zhong, J., Zhao, Y., Wan, C., Yang, B., Xu, J., Geng, E., Li, G., Huang, Y., Liu, H., & Liu, J. (2023). *The influencing factors of infectious complications after percutaneous nephrolithotomy: A systematic review and meta-analysis*. World Journal of Urology, *41*(3), 657–670.

Singh, U., Singh, V. K., Singh, V., Singh, A., & Singh, J. (2024). *Complications of percutaneous nephrolithotomy: Experience from a tertiary care center*. *Cureus, 16*(9), e69096.

oras, O., Bozkurt, I. H., Yonguç, T., Değirmenci, T., Arslan, B., Günlüsoy, B., Aydoğdu, Ö., & Minareci, S. (2015). *Risk factors for postoperative infectious complications following percutaneous nephrolithotomy: A prospective clinical study*. Urolithiasis, *43*(1), 55–60.