Postoperative infective complications following percutaneous nephrolithotomy

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Introduction: Percutaneous nephrolithotomy (PCNL) is recommended as the first choice of therapeutic strategy for patients with renal stones larger than 2 cm. It is reported that up to one-third of patients might have some perioperative complications, especially fever and urinary tract infections, which constitutes about 21%–39.8% of all the complications.

Primary and Secondary: The primary aim of the study was to study about the proportion of patients getting post-operative infective complications following PCNL. The secondary aim was to study the patient, stone and procedure related risk factors associated with the infective complications.

Settings and Design: This is an institution-based observational study.

Materials and Methods: All patients who underwent PCNL in the Department of Urology, Medical College, Thiruvananthapuram, during 3 years from September 2016– to August 2019, were included in the study. In this study, the demographic factors and factors related to the patient, stone, and the procedure were collected and analyzed.

Statistical Analysis Used: Data analysis was performed using SPSS version 22.0.

Results: During the 3-year period, a total of 201 patients with renal stones were treated with PCNL in our hospital. Of this 190 cases were taken for analysis. The mean age of patients was 47.7 years, 148 (77.9%) were male, 42 (22.1%) were female, The final outcomes evaluated were episodes of fever, documented urinary tract infection (UTI), pyelonephritis, and sepsis. Thirty-six (18.9%) patients had fever, of which 21 (11.1%) had UTI, 6 (3.1%) had pyelonephritis and 5 (2.6%) developed sepsis.

Conclusions: Post-PCNL complications are more commonly found in patients with history of preoperative UTI, previous history of renal surgeries, large stone burden, operative procedure more than 90 min, and presence of residual calculi.

Keywords: Percutaneous nephrolithotomy, pyelonephritis, sepsis, urinary tract infection

Access this article online

Website: www.urologyannals.com

DOI: 10.4103/UA.UA_153_20

How to cite this article: Kumar GM, Nirmal KP, Kumar GS. Postoperative infective complications following percutaneous nephrolithotomy. Urol Ann 2021;13:340-5.
INTRODUCTION

Percutaneous nephrolithotomy (PCNL) is recommended as the first choice of therapeutic strategy for patients with renal stones larger than 2 cm. It is also recommended as a treatment option for stones >1 cm in the lower pole and stones in the upper ureter where extracorporeal shock wave lithotripsy (ESWL) has failed or is contraindicated and in upper tracts which are not amenable to retrograde intrarenal surgery (RIRS).\(^1\) It is reported that up to one-third of patients might have some perioperative complications;\(^2\) especially the fever and a urinary tract infection, which constitutes about 21%–39.8% of all the complications.\(^3\) Among them infection is a potentially devastating one;\(^4\) and several studies have suggested sepsis as a leading perioperative cause of death.\(^5\) Numerous established data have assessed several potential perioperative factors affecting postoperative complications.\(^6\) Urosepsis has been reported to occur in 0.9%–4.7% of PCNL procedures.\(^7\) The duration of procedure, bacterial load in the urine, severity of obstruction, and presence of infected stone directly affect the incidence of febrile urinary tract infection (UTI) and/or urosepsis.\(^8\) This study is intended to assess the postoperative infective complications, and to evaluate the patient, stone and procedure related risk factors that affect the incidence of infective complications in PCNL.

MATERIALS AND METHODS

Aims and objectives

Primary
To study about the proportion of patients getting postoperative infective complications following PCNL.

Secondary
To study the patient, stone, and procedure related risk factors associated with infective complications following PCNL.

Study design
This is an institution-based observational study.

Study population
All patients who underwent PCNL in the Department of Urology, Medical College, Thiruvananthapuram, for a period of 3 years, September 2016 to August 2019, were included in the study.

After obtaining clearance from Institutional Research Committee and Institutional Ethics Committee, retrospective analysis of the patients who have undergone PCNL in our institution during 3 years from September 2016 to August 2019 were included in the study.

In this study, the information including demographics, clinical symptoms (pain, urinary tract infections), medical comorbidities (diabetes mellitus [DM], systemic hypertension) was collected and analyzed. History of previous surgeries (open, endoscopic, and ESWL) within the past 10 years were also taken into account. History of Double J (DJ) stenting or percutaneous nephrostomy (PCN) prior to the surgery was taken into consideration. Laboratory evaluation included Complete Blood Count CBC (Hb, TC, DC and ESR) and renal function test (blood urea and serum creatinine). Radiological evaluation of the stone was done with computerized tomography (CT), and functional evaluation was done with either intravenous urography or CT urogram. Stone characteristics that were assessed included, size (in cm\(^2\)), staghorn (complete or partial), presence of upper ureteric calculi, presence of hydronephrosis (HDN), and density of the stone. Complete staghorn calculi was defined as stone in ≥2 calices and partial staghorn calculi as stone in pelvis, branching into ≤2 calices in one region of kidney. As defined by previous studies, perioperative characteristics including operative time (less than or more than 90 min), number of tracts (one or more than one), size of the tracts (≤22 French (Fr), >22Fr), use of nephrostomy, and use of DJ stent were assessed. Preoperatively, sterile urine culture was ensured, and culture-specific antibiotics were given if detected to have positive urine culture. Patients with preoperative fever or positive urine culture were not taken for surgery until unless the fever subsides and urine is sterile. Percutaneous nephrostomy (PCN) tube was placed in patients with pyonephrosis. Prophylactic antibiotics were given for all patients. The second generation cephalosporins or culture-specific antibiotics were given at the induction of anesthesia.

Operative technique
Under general anesthesia, retrograde ureteric catheterization was done on the ipsilateral side. The patient was turned prone, and percutaneous access was obtained under fluoroscopic guidance by the operating surgeon using a diamond tip 18-G puncture needle. A hydrophilic guide wire was passed, over which tract dilatations were done using Alken metal dilators and an Amplatz sheath was placed into system. Stones were fragmented using pneumatic lithoclast and removed. Intraoperative stone clearance was assessed using fluoroscopy. A double J (DJ) stent/ureteric catheter/ nephrostomy tube was placed in most of the cases.

Postoperative period
Patients were admitted for 3-5 days in the ward. During
this period, monitoring of temperature, pulse rate, blood pressure, and total leukocyte count were done daily. Urine culture was done on the 1st postoperative day. Fever was defined as temperature >38°C on any of the postoperative days. The diagnosis of pyelonephritis was given to those patients who developed fever with a raised leukocyte count of 12,000/mm³. The diagnosis for sepsis required ≥2 criteria described below: (1) leukocyte count >12,000 or <4000/mm³; (2) temperature >38°C or <36°C; (3) heart rate >90/min; (4) respiratory rate >20/min. Ultrasound scan and X-ray were used for assessing the residual calculi and calculi more than 8 mm in length on any axis was taken as residual calculi.

Statistical analysis
Quantitative variables were expressed as mean, standard deviation. Qualitative variables were expressed as proportion. Comparison of quantitative variables between two groups were analyzed by Student’s t-test. The association between qualitative variables was analyzed by Chi-square test. A P < 0.05 was considered statistically significant. Data analysis was performed using SPSS version 22.0 (IBM SPSS Statistics for Windows, Version 22.0. IBM Corp, Armonk, NY, USA).

RESULTS
During the 3-year period, a total of 201 patients with renal stones were performed with PCNL in our hospital. Of this 190 cases were taken for analysis, as the data were incomplete in 11 cases. The mean age of patients was 47.7 years, 148 (77.9%) were male, 42 (22.1%) were female, 108 (56.8%) calculi were on the right side and 82 (43.2%) were left sided. The average size of the calculi was 6 cm³ and average density in CT was 1084.5 Hounse field units [Table 1]. Regarding the comorbidities, 48 (25.3%) were having DM, 64 (33.7%) were hypertensive. Twelve (6.3%) had urinary tract infection (UTI) preoperatively which was treated and urine was made sterile before the procedure. Four (2.1%) had urosepsis before the procedure for which one patient (0.5%) had undergone PCN. Preoperative DJ stenting was done in 38 (20%) patients [Table 2].

Sixty-seven (35.3%) patients had history of open or endoscopic surgery within the last 10 years. Fifty-five (28.9%) were staghorn calculi, and upper calyceal stones were present in 17 (8.9%) and upper ureteral stones were present in 16 (8.4%). Radiological evidence of hydronephrosis was present in 114 (60%) patients. The size of the tract used was less <22Fr in 95 (50%), >22Fr in 50%. The duration of the procedure was <90 min in 109 (57.4%) cases and more than 90 min in 81 (42.6%) cases. Residual calculi were seen in 25 (13.2%) cases. Two patients were readmitted after discharge for managing urinary tract infection.

The final outcomes evaluated were episodes of fever, documented UTI, pyelonephritis, and sepsis. Thirty-six (18.9%) patients had fever, of which 21 (11.1%) had UTI, 6 (3.1%) had pyelonephritis and 5 (2.6%) developed sepsis. Three patients expired [Table 3].

The risk factors for fever include the duration of surgery (>90 min) (P = 0.004), previous episodes of urosepsis (P = 0.004), history of renal surgery in the past (P = 0.033), and presence of residual calculi after the procedure (P = 0.004) [Table 4].

Table 1: Demographic factors

| Variable         | Mean     | SD       |
|------------------|----------|----------|
| Age              | 47.7     | 11.8     |
| Size cm³         | 6.0      | 7.8      |
| Density          | 1084.5   | 242.5    |
| Male             | 148      | 77.9     |
| Female           | 42       | 22.1     |
| Right            | 108      | 56.8     |
| Left             | 82       | 43.2     |

Table 2: Variables

| Variable         | Number of cases (%) |
|------------------|---------------------|
| Flank pain       | 180 (94.7)          |
| DM               | 48 (25.3)           |
| HTN              | 64 (33.7)           |
| History of UTI   | 12 (6.3)            |
| History of urosepsis | 4 (2.1)    |
| Preoperative stenting | 38 (20)    |
| Nephrostomy      | 1 (0.5)             |
| Past history of Surgery | 66 (34.7) |
| Staghorn         | 55 (28.9)           |
| Multiple         | 53 (27.9)           |
| Uppercaly        | 17 (8.9)            |
| Ureter           | 16 (8.4)            |
| Hydronephrosis   | 114 (60)            |
| DJ's (on table)  | 184 (96.8)          |
| Nephrostomy (on table) | 149 (78.4) |
| Puncture - one   | 163 (85.8)          |
| More than one puncture | 27 (14.2) |
| Tract size <22 Fr | 95 (50)             |
| Tract size >22 Fr | 95 (50)             |
| Duration <90 MTS | 109 (57.4)          |
| Duration >90 MTS | 81 (42.6)           |
| Residual calculi present | 25 (13.2) |

DM: Diabetes mellitus, HTN: Hypertension, UTI: Urinary tract infection, DJ'S: Double J stenting

Table 3: Outcomes

| Outcome       | Frequency (%) |
|---------------|---------------|
| Fever         | 36 (18.9)     |
| UTI           | 21 (11.1)     |
| Pyelonephritis| 6 (3.2)       |
| Sepsis        | 5 (2.6)       |

UTI: Urinary tract infection
The risk factors for urinary tract infection include duration of surgery more than 90 min \((P = 0.005)\), history of preoperative urosepsis \((P = 0.012)\), and presence of residual calculi \((P = 0.004)\) [Table 5].

Significant risk factor for pyelonephritis was found to be the presence of staghorn calculi \((P = 0.038)\) [Table 6]. Those who developed sepsis had incidence of UTI \((P = 0.002)\) in the past as one of the important risk factors [Table 7]. The only patient who had a preoperative nephrostomy for pyonephrosis had fever with pyelonephritis and features of sepsis in the post-operative period.

**DISCUSSION**

PCNL is still the most commonly performed surgery for large and complex renal stones. Though the safety and efficacy of the procedure has been defined, infectious complications are still the dangerous ones. Postoperative infectious complications were associated with prolonged hospitalization and additional antibiotic treatment. Numerous studies have concluded that sepsis is the most common cause for the perioperative death after PCNL.[8] The incidence of fever in our study was 18.9%, UTI 11.1%, pyelonephritis 3.2% and sepsis 2.6%. The prospective study conducted by Rivera et al.[9] in 227 patients had infectious complications in 37 (16%) patients: 11 (5%) UTI/pyelonephritis, 21 (9%) systemic inflammatory response syndrome (SIRS), 2 (0.9%) sepsis. In an even larger study investigating postoperative fever after PCNL Gutierrez et al.[10] utilizing the CROES (Clinical Research Office of the Endourological Society) data and found that 10.4% of the 5,313 patients with pre- and post-operative data developed a fever \((>38.5^\circ C)\). In a study published by Sharma et al. patients with renal failure (serum creatinine >1.4 mg/dl), staghorn stone, severe preoperative HDN, higher number of puncture, and longer duration of surgery were found to be significant factors associated with infectious complications.[11] Similar to our study, DM and complete staghorn calculus were found to be the major risk factors for infective complications in a study by Wei et al.[12] In a study by Yang et al. they observed that urine WBC and stone size were two risk factors for both fever and SIRS. The postoperative complication rates were 12.2% for fever and 27.4% for SIRS, respectively, in this study.[13] Some other studies also found that the stone burden, history of recurrent urinary tract infections were independent risk factors for infectious complications.[14-16] Studies showed that patients with recurrent urinary tract infections had a higher risk of developing SIRS after PCNL.[13] Besides, existing urinary tract infection would increase the risk of postoperative fever.[15] The number of punctures, size of the tract, preoperative stenting and the presence of

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**Table 4: Association between outcome and variables**

|                | Fever | UTI |
|----------------|-------|-----|
|                | Yes \((n=36)\), n (%) | No \((n=154)\), n (%) | \(P\) |
| Male           | 30 (20.3) | 118 (79.7) | 0.382 |
| Female         | 6 (14.3)  | 36 (85.7)  | 0.186 |
| Right          | 24 (22.2) | 84 (77.8)  | 0.139 |
| Left           | 12 (14.6) | 70 (85.4)  | 0.004 |
| <22            | 14 (44.7) | 81 (55.3)  | 0.033 |
| >22            | 22 (23.2) | 73 (76.8)  | 0.144 |
| <90            | 13 (11.9) | 96 (88.1)  | 0.004 |
| >90            | 23 (28.4) | 58 (71.6)  | 0.004 |
| One puncture   | 28 (17.2) | 135 (82.8) | 0.126 |
| >1 puncture    | 8 (29.6)  | 19 (71.4)  | 0.004 |
| Sepsis         | 5 (19.4)  | 145 (80.6) | 0.458 |
| DM             | 11 (22.9) | 37 (77.1)  | 0.033 |
| UTI            | 8 (66.7)  | 4 (33.3)   | 0.004 |
| Urosepsis      | 3 (75)    | 1 (25)     | 0.004 |
| Stenting       | 9 (23.7)  | 29 (76.3)  | 0.405 |
| Nephrostomy    | 1 (100)   | 0 (0)      | 0.038 |
| History of surgery | 18 (27.3) | 48 (72.7)  | 0.033 |
| Staghorn       | 14 (25.5) | 41 (74.5)  | 0.144 |
| Multiple       | 8 (15.1)  | 45 (84.9)  | 0.399 |
| Uppercalyx     | 2 (11.8)  | 15 (88.2)  | 0.428 |
| Ureter         | 4 (25)    | 12 (75)    | 0.192 |
| Hydronephrosis | 21 (18.4) | 93 (81.6)  | 0.821 |
| DJS            | 35 (19)   | 149 (81)   | 0.885 |
| Nephrostomy    | 28 (18.8) | 121 (81.2) | 0.917 |
| Residual calculi | 10 (40)   | 15 (60)    | 0.004 |

**Table 5: Association between outcome and variables**

|                | UTI | \(P\) |
|----------------|-----|-------|
|                | Yes \((n=21)\), n (%) | No \((n=169)\), n (%) | \(P\) |
| Male           | 18 (12.2) | 130 (87.8) | 0.360 |
| Female         | 3 (7.1)   | 39 (92.9)  | 0.152 |
| Right          | 15 (13.9) | 93 (86.1)  | 0.152 |
| Left           | 6 (7.3)   | 76 (92.7)  | 0.247 |
| <22            | 8 (8.4)   | 87 (91.6)  | 0.004 |
| >22            | 13 (13.7) | 82 (86.3)  | 0.005 |
| <90            | 6 (5.5)   | 103 (94.5) | 0.005 |
| >90            | 15 (18.5) | 66 (81.5)  | 0.111 |
| One puncture   | 16 (9.8)  | 147 (90.2) | 0.182 |
| >1 puncture    | 5 (18.5)  | 22 (81.5)  | 0.871 |
| DM             | 5 (10.4)  | 43 (89.6)  | 0.346 |
| HTN            | 9 (14.1)  | 55 (85.9)  | 0.908 |
| UTI            | 3 (25)    | 9 (750)    | 0.004 |
| Urosepsis      | 2 (50)    | 2 (50)     | 0.128 |
| Stenting       | 4 (10.5)  | 34 (89.5)  | 0.004 |
| Nephrostomy    | 1 (100)   | 0 (0)      | 0.004 |
| History of surgery | 11 (16.7) | 55 (83.3)  | 0.072 |
| Staghorn       | 9 (16.4)  | 46 (83.6)  | 0.136 |
| Multiple       | 4 (7.5)   | 42 (92.5)  | 0.339 |
| Uppercalyx     | 0 (0)     | 17 (100)   | 0.128 |
| Ureter         | 2 (12.5)  | 14 (87.5)  | 0.871 |
| Hydronephrosis | 14 (12.3) | 100 (87.7) | 0.508 |
| DJS            | 21 (11.4) | 163 (88.6) | 0.380 |
| Nephrostomy    | 18 (12.1) | 131 (87.9) | 0.389 |
| Residual calculi | 7 (28)    | 18 (72)    | 0.004 |

**DM:** Diabetes mellitus, **HTN:** Hypertension, **UTI:** Urinary tract infection, **DJS:** Double J stenting
and that patient had developed fever, pyelonephritis, and later developed sepsis. Three patients expired in the postoperative period, 1 due to sepsis, and 2 due to pulmonary embolism and acute myocardial infarction, respectively. In contrast to other studies our study showed that previous history of renal surgery is one of the risk factors for fever and sepsis.

**CONCLUSIONS**

Post-PCNL complications are more commonly found in patients with a history of preoperative UTI, previous history or renal surgeries, large stone burden, operative procedure more than 90 min and presence of residual calculi. The number or size of the tracts was not associated with significant risk. The main fallacy of our study was its retrospective nature. This study was conducted in a single institute with different surgeons performing the same procedure.

**Financial support and sponsorship**

Nil.

**Conflicts of interest**

There are no conflicts of interest.

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**Table 6: Association between outcome and variables**

| Variable                  | Yes (n=6), n (%) | No (n=184), n (%) | P    |
|---------------------------|-----------------|------------------|------|
| Male                      | 4 (2.7)         | 144 (97.3)       | 0.501|
| Female                    | 2 (4.8)         | 40 (95.2)        | 0.087|
| Right                     | 3 (2.8)         | 105 (97.2)       | 0.731|
| Left                      | 3 (3.7)         | 79 (96.3)        | 0.682|
| <22 Fr                    | 2 (2.1)         | 93 (97.9)        | 0.407|
| >22 Fr                    | 4 (4.2)         | 91 (95.8)        | 0.038|
| <90 min                   | 2 (1.8)         | 107 (98.2)       | 0.226|
| >90 min                   | 4 (4.9)         | 77 (95.1)        | 0.942|
| One puncture              | 5 (3.1)         | 158 (96.9)       | 0.861|
| >1 puncture               | 1 (3.8)         | 26 (96.2)        | 0.000|
| DM                        | 3 (6.3)         | 45 (93.8)        | 0.156|
| HTN                       | 3 (4.7)         | 61 (95.3)        | 0.390|
| UTI                       | 3 (25)          | 9 (75)           | 0.000|
| Stenting                  | 1 (2.6)         | 37 (97.4)        | 0.836|
| Nephrostomy               | 1 (100)         | 0 (0)            | 0.000|
| History of surgery        | 2 (3)           | 64 (97)          | 0.942|
| Staghorn                  | 4 (7.3)         | 51 (92.7)        | 0.038|
| Multiple                  | 0 (0)           | 53 (100)         | 0.122|
| Uretercalyx               | 0 (0)           | 17 (100)         | 0.435|
| Ureter                    | 0 (0)           | 16 (100)         | 0.450|
| Hydronephrosis            | 4 (3.5)         | 110 (96.5)       | 0.735|
| DJS                       | 6 (3.3)         | 178 (96.7)       | 0.653|
| Nephrostomy               | 5 (3.4)         | 144 (96.6)       | 0.766|
| Residual calculi          | 2 (8)           | 23 (92)          | 0.137|

DM: Diabetes mellitus, HTN: Hypertension, UTI: Urinary tract infection, DJS: Double J stenting

**Table 7: Association between outcome and variables**

| Variable                  | Yes (n=5), n (%) | No (n=185), n (%) | P    |
|---------------------------|-----------------|------------------|------|
| Male                      | 4 (2.7)         | 144 (97.3)       | 0.908|
| Female                    | 1 (2.4)         | 41 (97.6)        | 0.441|
| Right                     | 2 (1.9)         | 106 (98.1)       | 0.070|
| Left                      | 3 (3.7)         | 79 (96.3)        | 0.207|
| <22                       | 2 (2.1)         | 93 (97.9)        | 0.650|
| >22                       | 3 (3.2)         | 92 (96.8)        | 0.002|
| <90                       | 1 (0.9)         | 108 (99.1)       | 0.087|
| >90                       | 4 (4.9)         | 77 (95.1)        | 0.492|
| One puncture              | 4 (2.5)         | 159 (97.5)       | 0.707|
| >1 puncture               | 1 (3.8)         | 26 (96.2)        | 0.257|
| DM                        | 3 (6.3)         | 45 (93.8)        | 0.000|
| HTN                       | 3 (4.7)         | 61 (95.3)        | 0.000|
| UTI                       | 2 (16.7)        | 10 (83.3)        | 0.038|
| Urosepsis                 | 2 (50)          | 2 (50)           | 0.000|
| Stenting                  | 0 (0)           | 38 (100)         | 0.477|
| Nephrostomy               | 1 (100)         | 0 (0)            | 0.212|
| History of surgery        | 1 (1.5)         | 65 (98.5)        | 0.483|
| Staghorn                  | 3 (5.5)         | 52 (94.5)        | 0.121|
| Multiple                  | 1 (1.9)         | 52 (98.1)        | 0.690|
| Uretercalyx               | 0 (0)           | 17 (100)         | 0.477|
| Ureter                    | 0 (0)           | 16 (100)         | 0.492|
| Hydronephrosis            | 3 (2.6)         | 111 (97.4)       | 1.000|
| DJS                       | 5 (2.7)         | 179 (97.3)       | 0.682|
| Nephrostomy               | 5 (3.4)         | 144 (96.6)       | 0.235|
| Residual calculi          | 1 (4)           | 24 (96)          | 0.646|

DM: Diabetes mellitus, HTN: Hypertension, UTI: Urinary tract infection, DJS: Double J stenting
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