



ORIGINAL ARTICLE

Risk factors for fever and sepsis after percutaneous nephrolithotomy



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Abstract *Objective:* Percutaneous nephrolithotomy (PCNL) is commonly used in the management of large renal stones. Postoperative infections are one of the most common complications of this procedure. The present study is to determine and assess the factors that may increase the risk to develop fever and urinary sepsis after PCNL.

Methods: A total of 60 patients (38 males and 22 females) with a mean age of 40.25 years enrolled in this study in Sulaimania Teaching Hospital. Patients had renal stone disease need operation with different socioeconomic status, body mass index and different type and size of stones were included in this study. Patients with preoperative positive urine culture and sensitivity were excluded. Preoperative investigations done for all patients. All Patients received prophylactic antibiotic gentamicin intravenously at the induction of anaesthesia. Renal pelvis urine sample were taken from all patients after puncturing the pelvicalyceal system and send for culture and sensitivity. Patients were monitored closely in the postoperative period for the development of fever and sepsis.

Results: Mean duration of the operations was 77.08 min ranged 40–120 min. All patients had postoperative nephrostomy tube. Seventeen (28.33%) patients developed post PCNL fever and the statistically significant factors for post PCNL fever were diabetes mellitus (DM) ($p = 0.001$), stone burden ($p = 0.001$), number of the stones ($p < 0.001$), degree of hydronephrosis ($p = 0.001$), duration of the operation ($p < 0.001$), residual stones ($p = 0.001$) and number of tracts ($p = 0.038$). Three (5.00%) patients developed post PCNL sepsis, and the statistically significant risk factors for post PCNL sepsis were duration of the operation ($p = 0.013$) and intraoperative blood loss, postoperative drop in haemoglobin (HB) level ($p = 0.046$).

Conclusion: DM, staghorn stones, degree of hydronephrosis, duration of the operation and number of tracts are risk factors for post PCNL fever, while number of stones, intraoperative blood loss, duration of the operation and residual stones are risk factors for post PCNL sepsis.

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1. Introduction

Stone disease is common and affects 0.131% of the population at any time [1]. Numerous factors influence choice of treatment, such as stone characteristic, availability of equipment, complications and additional procedures required together with patient preference [2]. Percutaneous nephrolithotomy (PCNL) is an effective, safe and preferred treatment option for complex or large volume nephrolithiasis [3,4]. However, PCNL carries a considerable risk, fever occur in 21%–39.8% of the patients [5].

Fever following PCNL may be secondary to urinary tract infection (UTI) which is significant clinically regarding the development of post-PCNL sepsis [6]. Determining which patients are at greatest risk is extremely important [7,8]. However, fever may also originate from the release of the inflammatory mediators during surgical manipulation, systemic inflammatory response syndrome (SIRS) [8,9]. Several studies showed post-PCNL urosepsis occurs in 0.3%–9.3% of patients, it is potentially life threatening condition and the most common cause of death [6,8,10]. Factors found to increase the risk of urosepsis are female sex, diabetes mellitus (DM), body mass index (BMI), and pelvicalyceal system dilatation [9,11]. Several intraoperative factors are average renal pressure sustained during PCNL, operative time, number of tracts and degree of blood loss [6,8]. Urosepsis that occur as a result of manipulation during PCNL can be catastrophic despite negative preoperative bladder urine culture and prophylactic antibiotic [9,12]. Positive renal pelvis urine culture is regarded as a significant risk factor for post PCNL fever [12,13]. Positive stone and pelvic urine culture is better predictors of the potential post-PCNL sepsis than bladder urine culture. One of the most important aspects of study in the management of complications of PCNL is the use of prophylactic antibiotic for prevention of sepsis [14,15]. The use of short course of preoperative antibiotic has been found to significantly decrease the rate of post-PCNL fever and sepsis. American Urological Association (AUA) guidelines recommend the use of prophylactic antibiotic preoperatively for a duration of less than 24 h [8]. The Clavien grading system is an excellent classification system that provides an objective grading system for complications of PCNL. The simplicity and ease of use of the Clavien classification system to 8 grade postoperative complications has resulted in its widespread adoption in surgery [16–18].

2. Patients and methods

2.1. Clinical data's collection

We performed a prospective clinical study in 60 patients, 38 males (63.3%) and 22 females (36.7%), who underwent PCNL in the Sulaimaniyah Teaching Hospital between June 2013

and June 2014. The study was approved by the Iraqi Board of Urology and Local Ethical Committee of the hospital. Patients with different age, gender, socioeconomic status, weight, different type and size of stones were included in this study. Preoperative fever, positive urine culture and nephrostomy tube were excluded from the study.

2.2. Patient preparation and operation

Patients were evaluated by history, physical examination, and investigations. All patients had mid-urine exam and culture. Haematological and biochemical determination, bleeding profiles, viral screen, blood group and cross match with compatible blood preparation were performed in all the patients. All patients had ultrasound examinations of the kidney and bladder and imaging study like KUB and excretory urography. In some patients with unclear anatomy of urinary tract, computed tomography (CT) with contrast enhancement was performed. Preoperative information including age, sex, BMI, DM, degree of hydronephrosis, number and size of the stones were recorded. All patients received a single dose of prophylactic antibiotics at the induction of anaesthesia. After patient intubation and induction of anaesthesia, the ipsilateral ureter was catheterized, then the patient turned prone. The costovertebral area prepared for needle puncture. Once percutaneous access achieved into the pelvicalyceal of the kidney, urine from the pelvicalyceal system was aspirate and sent to the laboratory as a pelvic urine for culture. Any growth of more than 100,000 bacteria was regarded as a positive urine culture (infected urine). The tract then dilated using concentric metal dilators (20–30 Fr) according to the stone burden and a suitable Amplatz sheath size was placed in the tract to continue the procedure using pneumatic lithotripsy under low pressure irrigation.

2.3. Post-operative management

All patients were left with a nephrostomy tube for at least 48 h with or without double J (JJ) stent insertion. Postoperatively the number of tracts, operative time and results of pelvic urine culture were collected. Postoperative International Sepsis Definitions Conference of 2001 was used to identify patients with SIRS. According to it if there is development of two or more of four criteria, namely fever less than 36 °C or greater than 38 °C, heart rate greater than 100 beats/min, respiratory rate greater than 20 breaths/min or PaCO₂ lower than 32 mmHg, and white blood cell (WBC) count greater than 12 × 10⁹/L or less than 4 × 10⁹/L, the patient is documented to have fever and sepsis when there is SIRS with documented infection. Any development of fever were followed. Development of persistent rising fever, rigor, tachycardia, tachypnoea and changing level of consciousness, the patient was regarded as entering a state of

sepsis, and was kept in intensive care unit until all signs and symptoms of sepsis returned to normal.

2.4. Data entry and analysis

The data were entered into a Microsoft Excel Spreadsheet after data cleaning and then were transported into SPSS (IBM, IL, USA) for statistical analysis.

Descriptive statistics (mean, standard deviation, minimum, maximum, numbers and percentage) were calculated for variables. Probability measure were used, the analytical statistics was done to find the relations between variables with p value < 0.05 considered as significant.

3. Results

3.1. General patient informations

Sixty patients (38 males and 22 females) were included in this study, their mean age was 40.25 years. The mean number of stones was 2.32, and the mean size of stones was 30.8 mm (Table 1). The history and physical examinations of patients were shown in Table 2.

3.2. Intraoperative data

Number of tracts created were: 45 (75.0%) one tract, 14 (23.3%) two tracts and one (1.7%) had three tracts.

Location of stones: 17 are pelvic (28.3%), 24 (40.0%) are calyceal and combined pelvic and calyceal stones in 19 patients (31.7%). Thirteen patients (21.7%) had severe hydronephrosis, 36 patients (60.0%) had moderate hydronephrosis and 11 patients (18.3%) had mild hydronephrosis. Nine patients (15.0%) had staghorn calculi, 9 (15.0%) had partial staghorn calculi and 42 (70.0%) had non staghorn calculi.

3.3. Operative care findings

JJ stent was inserted in 51 patients (85.0%), and nephrostomy tube was inserted in all patients (100%). Blood transfusion was given to five (8.3%) patients, and pelvic urine positive was found in five (8.3%) patients. Residual stone was seen in 19 (31.7%) patients.

3.4. Postoperative data

Duration of operation was (77.08 ± 21.53) min (mean ± SD), WBC was (10.946 ± 2.892) × 10⁹/L, haemoglobin was (12.45 ± 1.48) g/dL, blood urea nitrogen was (3.213 ± 1.702) mmol/L (Table 3).

3.5. Fever occurrence

Fever >38°C postoperatively developed with p value statistically significant in 17 (28.3%) patients totally; five (62.5%) diabetic patients, seven (77.8%) staghorn stone, four (44.4%) partial staghorn stone, 10 (27.8%) moderate hydronephrosis, six (54.5%) mild hydronephrosis, and 10 patients with residual stones see (Table 4).

Table 1 General information, haematological and biochemical determination of patients before operation ($n = 60$).

| Variable | Min–max | Mean ± SD |
|------------------------------|--------------|---------------|
| Age (year) | 3.5–76.0 | 40.25 ± 15.43 |
| No. of stones | 1–6 | 2.32 ± 1.37 |
| Size of stones (mm) | 11–70.0 | 30.8 ± 13.6 |
| WBC (×10 ⁹ /L) | 7.2–13 | 7.670 ± 2.097 |
| HB (g/dL) | 10.4–17.4 | 13.99 ± 1.61 |
| Blood urea nitrogen (mmol/L) | 1.33–8.56 | 3.26 ± 1.53 |
| Serum creatinine (μmol/L) | 26.52–212.16 | 85.13 ± 33.59 |

WBC, white blood cell count; HB, haemoglobin.

Table 2 Patients information during history and physical examinations ($n = 60$).

| Parameter | n (%) |
|-------------------------------|-----------|
| DM | |
| Positive | 8 (13.3) |
| Negative | 52 (86.7) |
| Hypertension | |
| Positive | 11 (18.3) |
| Negative | 49 (81.7) |
| PCNL | |
| Positive | 2 (3.3) |
| Negative | 58 (96.7) |
| URS | |
| Positive | 11 (18.3) |
| Negative | 49 (81.7) |
| History of open renal surgery | |
| Positive | 17 (28.3) |
| Negative | 43 (71.7) |
| History of ESWL | |
| Positive | 24 (40.0) |
| Negative | 36 (60.0) |

DM, diabetes mellitus; PCNL, percutaneous nephrolithotomy; URS, ureterorenoscopy; ESWL, extra-corporeal lithotripsy.

Table 3 Shows mean and standard deviations of duration of the operation and postoperative investigations.

| Variable | Min | Max | Mean ± SD |
|------------------------------|--------|----------|------------------|
| Duration of operation (min) | 40 | 120 | 77.08 ± 21.53 |
| WBC (×10 ⁹ /L) | 6 | 25 | 10.946 ± 2.892 |
| HB (g/dL) | 9.9 | 16.5 | 12.45 ± 1.48 |
| Blood urea nitrogen (mmol/L) | 1.428 | 11.424 | 3.213 ± 1.702 |
| Serum creatinine (μmol/L) | 17.680 | 265.2000 | 100.776 ± 45.084 |

WBC, white blood cell; HB, haemoglobin.

3.6. Sepsis occurrence

Sepsis developed in three patients (5.0%) with $p = 0.902$, statistically not significant.

Sepsis with a p value statistically significant occurs in three (12.0%) over weight patients, one diabetic patient (12.5%); one patient (11.1%) out of nine with staghorn stone burden, one patient (11.1%) out of nine with partial staghorn stone and one patient (2.4%) out of 42 with non staghorn stone (Table 4).

Fever with p value of <0.001 is statistically significant found in patients with rising WBC and rising serum creatinine, number of stones and duration of the operation. Sepsis with p value statistically significant found in patients with prolonged duration of the operation, rising WBC and decreased haemoglobin (Table 5).

4. Discussion

There are several studies reported on post PCNL fever, all with different results ranged incidence between 10%–32%, in our study 17 patients (28.3%) developed post PCNL fever

(axillary temperature above 38°C). A number of factors may explain the wide variation in the incidence of post PCNL fever among studies. Female sex is a risk factor for the development of post PCNL fever [15] others not [4], in this study female sex was not a risk factor $p = 0.890$. It was reported in one study that BMI >18.5 kg/m² was regarded as risk factor for post PCNL fever [6]. In the current study eight of the 17 patients with postoperative fever were obese. No fever was found in underweight patients. The p value for post PCNL fever and BMI was 0.446, showing no statistically significant, this is comparative to a Korean study [5]. DM is regarded as a risk factor for fever post PCNL [8,5,16], and in the current study DM is a risk factor for fever; among eight diabetic patients five (62.5%) developed fever with a ($p = 0.001$). The impact of stone burden as a risk factor for post PCNL fever is clear and confirmed by several studies [8,5,19] and in this study stone burden was a major risk factor facilitating the development of post PCNL fever.

Hydronephrosis is regarded as a risk factor for post PCNL fever [8,12,19]. In the current study the degree of hydronephrosis was also a risk factor for post PCNL fever development ($p = 0.001$). Postoperative JJ stent insertion can

Table 4 Incidences of sepsis and fever.

| Variable | Total (n) | Fever | | p -Value | Sepsis | | p -Value |
|---------------------------------|-----------|----------------|--------------------|------------|----------------|--------------------|------------|
| | | Present, n (%) | Not present, n (%) | | Present, n (%) | Not present, n (%) | |
| Sex | | | | | | | |
| Male | 38 | 11 (28.9) | 27 (71.1) | 0.890 | 2 (5.3) | 36 (94.7) | 0.902 |
| Female | 22 | 6 (27.3) | 16 (72.6) | | 1 (4.5) | 21 (95.5) | |
| BMI group | | | | | | | |
| Under weight | 7 | 0 (0.0) | 7 (100.0) | 0.446 | 0 (0.0) | 7 (100.0) | 0.243 |
| Normal | 6 | 2 (33.3) | 4 (66.7) | | 0 (0.0) | 6 (100.0) | |
| Over weight | 25 | 7 (28.0) | 18 (72.0) | | 3 (12.0) | 22 (88.0) | |
| Obese | 22 | 8 (36.4) | 14 (63.6) | | 0 (0.0) | 22 (100.0) | |
| Diabetes mellitus | | | | | | | |
| Positive | 8 | 5 (62.5) | 3 (37.5) | 0.001 | 1 (12.5) | 7 (87.5) | 0.296 |
| Negative | 52 | 12 (23.1) | 40 (76.9) | | 2 (3.8) | 50 (96.2) | |
| Stone burden | | | | | | | |
| Staghorn | 9 | 7 (77.8) | 2 (22.2) | 0.001 | 1 (11.1) | 8 (88.9) | 0.364 |
| Partial staghorn | 9 | 4 (44.4) | 5 (55.6) | | 1 (11.1) | 8 (88.9) | |
| Not staghorn | 42 | 6 (14.3) | 36 (85.7) | | 1 (2.4) | 41 (97.6) | |
| Degree of hydronephrosis | | | | | | | |
| Severe | 13 | 1 (7.7) | 12 (92.3) | 0.001 | 0 (0.0) | 13 (100.0) | 0.349 |
| Moderate | 36 | 10 (27.8) | 26 (72.2) | | 3 (8.3) | 33 (91.7) | |
| Mild | 11 | 6 (54.5) | 5 (45.5) | | 0 (0.0) | 11 (100.0) | |
| JJ stent | | | | | | | |
| Inserted | 51 | 17 (33.3) | 34 (66.7) | 0.041 | 3 (5.9) | 48 (94.1) | 0.243 |
| Not inserted | 9 | 0 (0.0) | 9 (100.0) | | 0 (0.0) | 9 (100.0) | |
| Pelvis urine C/S | | | | | | | |
| Positive | 5 | 3 (60.0) | 2 (40.0) | 0.101 | 0 (0.0) | 5 (100.0) | 0.591 |
| Negative | 55 | 14 (25.5) | 41 (74.5) | | 3 (5.5) | 52 (94.5) | |
| Residual stones | | | | | | | |
| <5 mm | 9 | 2 (22.2) | 7 (77.8) | 0.001 | 1 (11.1) | 8 (88.9) | 0.001 |
| 5–10 mm | 5 | 4 (80.0) | 1 (20.1) | | 0 (0.0) | 5 (100.0) | |
| >10 mm | 5 | 4 (80.0) | 1 (20.1) | | 2 (40.0) | 3 (60.0) | |
| No residual stones | 41 | 7 (17.07) | 34 (82.92) | | 0 (100) | 41 (100) | |
| Total | 60 | 17 | 43 | | 3 | 57 | |

BMI, body mass index; JJ, double J ureteric catheter; C/S, culture and sensitivity test; DM, diabetes mellitus.

Table 5 Patient conditions in relation with fever and sepsis.

| Patients condition | Fever present <i>n</i> = 17, mean ± SD | Fever not present <i>n</i> = 43, mean ± SD | <i>p</i> -Value | Sepsis present <i>n</i> = 3, mean ± SD | Sepsis not present <i>n</i> = 57, mean ± SD | <i>p</i> -Value |
|---------------------------------|-------------------------------------------|-----------------------------------------------|-----------------|-------------------------------------------|------------------------------------------------|-----------------|
| Age (year) | 43.0 ± 12.4 | 39.1 ± 16.5 | 0.314 | 52.6 ± 13.4 | 39.60 ± 15.4 | 0.155 |
| No. of stones | 3.47 ± 1.37 | 1.86 ± 1.08 | <0.001 | 4.33 ± 1.52 | 2.21 ± 1.29 | 0.008 |
| Size of stones (mm) | 42.2 ± 13.1 | 26.3 ± 11.1 | <0.001 | 40.0 ± 10.0 | 30.3 ± 13.7 | 0.238 |
| No. of tracts | 1.47 ± 0.51 | 1.19 ± 0.45 | 0.038 | 1.33 ± 0.57 | 1.26 ± 0.48 | 0.808 |
| Duration of the operation (min) | 97.65 ± 14.37 | 68.9 ± 18.2 | <0.001 | 106.67 ± 11.54 | 75.5 ± 20.8 | 0.013 |
| WBC (×10 ⁹ /L) | 13.370 ± 3.469 | 9.674 ± 2.205 | <0.001 | 17.500 ± 6.500 | 10.601 ± 2.209 | <0.001 |
| HB (g/dL) | 11.85 ± 1.18 | 12.69 ± 1.53 | 0.048 | 10.80 ± 0.72 | 12.54 ± 1.46 | 0.046 |
| Blood urea nitrogen (mmol/L) | 0.11 ± 0.33 | 3.07 ± 10.08 | 0.323 | 3.63 ± 4.50 | 3.19 ± 9.74 | 0.670 |
| Serum creatinine (μmol/L) | 129.95 ± 0.72 | 89.28 ± 0.33 | 0.001 | 144.09 ± 0.41 | 98.12 ± 0.51 | 0.091 |

WBC, white blood cell; HB, haemoglobin.

increase the risk of post PCNL fever development [8,15], and it is the same in the current study ($p = 0.041$). Positive renal pelvis urine culture is regarded as a significant risk factor for post PCNL fever [9,12,13]. In the current study positive renal pelvis urine culture was not a significant risk factor for post PCNL fever. Residual stones of different size is regarded as a risk factor [4,8,19], while others denied it [9]. In the current study presence of residual stones was a significant risk factor for post PCNL fever. Number of tracts created, number and size of stones were highly significant risk factors for post PCNL fever development, and this finding is comparative to findings in several studies [5,7,8].

Duration of the operation is a risk factor for post PCNL fever [5,8,19]. In the current study the operative time was highly significant ($p < 0.001$). Rising WBC counts and post-operative serum creatinine had a significant correlation with post PCNL. A drop in the postoperative HB ($p = 0.048$).

Sepsis after PCNL is uncommon but potentially life threatening [9,13]. The incidence of postoperative sepsis differs between studies, some reported incidence of 2.4%, others reported incidence of 0.3%–4.7% [7] and 1.4% [17]. In the current study the incidence of post PCNL sepsis was 5.0%, this is comparative with the study done in Massachusetts by Kreydin and Eisner [8] with reported incidence of ~4.7%.

Number of stones was a risk factor for post PCNL sepsis ($p = 0.008$). Duration of the operation was a risk factor for post PCNL sepsis ($p = 0.013$). The rising of postoperative WBC counts in patients with continuous fever in the second and third postoperative days related significantly with post PCNL sepsis. A drop of HB postoperative was a risk factor for post PCNL sepsis ($p = 0.046$). Positive renal pelvis urine culture is regarded as a significant risk factor for post PCNL sepsis by several studies [12]. In the current study positive renal pelvis urine was not a risk factor for post PCNL sepsis.

5. Conclusion

Predictors of post PCNL fever include: DM, stone burden and number, hydronephrosis, number of tracts, duration of the operation, intraoperative bleeding, presence of residual stones and presence of postoperative JJ stent. Development of post PCNL fever significantly correlated with

postoperative rising in WBC and serum creatinine and dropping in the HB levels.

Predictors of post PCNL sepsis include: number of stones, duration of the operation, bleeding and presence of residual stones.

Development of post PCNL sepsis significantly correlates with postoperative rising in WBC and dropping in the HB levels.

Conflicts of interest

The authors declare no conflict of interest.

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