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Prediction of Urosepsis Following PCNL: A Retrospective Cohort Study

Zulker Naimul Islam[1*], Monirul Islam[2], Probir Kumar Roy[3], Nitai Pada Biswas[4]

[1]Assistant Registrar, Department of Urology, National Institute of Kidney diseases and Urology, Shere-e-Banglanagar, Dhaka, Bangladesh
[2]Research Assistant, Department of Urology, National Institute of Kidney diseases and Urology, Shere-e-Banglanagar, Dhaka, Bangladesh
[3]Research Assistant, Department of Urology, National Institute of Kidney diseases and Urology, Shere-e-Banglanagar, Dhaka, Bangladesh
[4]Ex Professor & Head, Department of Urology, National Institute of Kidney Diseases and Urology, Shere-e-Banglanagar, Dhaka, Bangladesh

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***Corresponding author:** Zulker Naimul Islam
Assistant Registrar, Department of Urology, National Institute of Kidney diseases and Urology, Shere-e-Banglanagar, Dhaka, Bangladesh

Abstract **Original Research Article**

Introduction: The procedure of percutaneous nephrolithotomy (PCNL) is considered a minimally invasive method for removing stones from the kidneys or upper ureters. PCNL can cause a wide range of complications, such as urosepsis, a rare but serious complication. ***Methods:*** A retrospective cohort study of patients who underwent PCNL from the period June 2022 to July 2023 was conducted at Department of Urology, National Institute of Kidney diseases and Urology, Shere-e-Banglanagar, Dhaka, Bangladesh. Data were collected by chart review using the Best CARE system. SPSS version 23 (IBM Corporation, Armonk, NY, USA) was used. Qualitative variables were expressed as percentages and frequencies. The chi-square test was used to compare the qualitative variables. The K-S test was used to check the normality of the data. Quantitative variables were compared between groups using the independent sample t-test and the nonparametric Mann-Whitney test. Fisher's exact test was used to compare categorical variables. ***Results:*** A total of 100 patients were included in this study. The mean age of the participants overall was found to be 49. About 70 (70%) of the participants were male. Regarding risk factors for urosepsis, diabetes mellitus was found in 35 (38%) of the participants. The incidence of urosepsis following PCNL was found to be 3 (1.9%) of the patients. The most frequently reported indication was found to be unilateral renal stones. The most frequently reported type of stone in the analysis was found to be calcium oxalate in nearly two-thirds 63 (63%) of the patients. ***Conclusion:*** The incidence of urosepsis among the patients who underwent PCNL was less than 2%. Diabetes mellitus, followed by hypertension, were the most prevalent co-morbidities among the participants. Inj Meropenam was the antibiotic of choice when treating patients and following urosepsis.

Keywords: Nephrolithotomy, Percutaneous, Urosepsis, Risk Factors, Patients.

INTRODUCTION

Kidney stones are a common urological condition that affects approximately 12% of the world's population. Percutaneous nephrolithotomy (PCNL) is considered a minimally invasive procedure used to remove large kidney or ureteric stones [1]. After decades of development, percutaneous nephrolithotomy (PCNL) has become one of the main surgical methods for upper urinary tract stones, especially those with kidney stones or upper ureteral stones larger than 2 cm [2]. However, it is important to consider the potential postoperative complications caused by PCNL [3,4]. PCNL can result in a variety of complications, including bleeding, injury to the surrounding structure, infection, positioning-related injuries, thromboembolic diseases, and even death [5]. Urosepsis is a rare but serious complication after PCNL. Sometimes, urosepsis can cause septic shock and be lethal if left untreated or not treated properly [6,7]. The most common bacteria associated with urosepsis are Escherichia coli, Proteus, Klebsiella, and Pseudomonas spp., among others that are less frequent [8]. Urosepsis is a serious postoperative complication of PCNL. If it is not properly treated in a timely manner, it can cause septic shock and can be lethal [9]. Clinical studies have shown that diabetes mellitus was independently associated with increased risk of infectious complications after PCNL (OR = 14.6, P = 0.001) [10]. Therefore, when implementing PCNL in patients with DM, early detection of patients with

potential urosepsis risk is extremely important. In practice, the first stage of urosepsis often lacks clinical symptoms, which makes it difficult to identify the occurrence of urosepsis at an early stage [11]. Many studies have shown that there are many risk factors for urosepsis after PCNL, including preoperative, intraoperative, and postoperative factors. Positive urine culture, stone size, stone complexity, and residual stones were the main risk factors for urosepsis [12,13].

MATERIALS AND METHODS

A retrospective cohort study of patients who underwent PCNL from the period June 2022 to July 2023 was conducted at Department of Urology, National Institute of Kidney diseases and Urology, Shere-e-Banglanagar, Dhaka, Bangladesh. A total of 100 patients were included in this study. Both genders were included. Exclusion criteria were applied for patients who underwent the procedure outside the institution and patients with missing data. Non-probability consecutive sampling included all patients who met the inclusion criteria.

The main categories of the sheet used included the following: demographic data, surgery data, comorbidities, hospital course that includes ICU admission, antibiotic course, stone analysis, and post-discharge data that includes antibiotic and emergency room visits, time of JJ stent removal, residual stone, and subsequent intervention.

Data were collected through Microsoft Excel (Microsoft, Redmond, WA, USA) and transferred to Statistical Package for Social Sciences (SPSS) Statistics v.23 (IBM Corp., Armonk, NY, USA) for statistical analysis. The data were checked for missing information, and new variables were recorded and computed based on the extracted data. Once the distribution of the variables was determined, appropriate correlation analyses were chosen. All assumptions were satisfied for each analysis. Moreover, qualitative variables were expressed as percentages and frequencies. A chi-square test was used to compare the qualitative variables. The K-S test was used to check the normality of the data. Quantitative variables were compared between groups using the independent sample t-test and the nonparametric Mann-Whitney test. Fisher's exact test was used to compare categorical variables. A P-value of 0.05 was considered significant.

RESULTS

A total of 100 patients were included in this study. The mean age of the patients overall was found to be 49.9 ± standard deviation (SD) of 18.5 years (range of 6-88 years). The mean age of the patients with urosepsis was found to be 40.7 ± 31 years old. The mean age of the patients with no urosepsis was found to be 50.1 ± 18.3. The mean BMI overall was found to be 29.3±7.3, the mean BMI for patients with urosepsis was found to be 18.9 ± 7.8, the mean BMI for patients without urosepsis was found to be 29.5±7.1, and BMI was found to be significant with urosepsis (p-value = 0.012), as patients with a higher BMI were found to develop urosepsis less frequently than those with a normal or low BMI. About 70 (70%) of the participants were males and 30 (30%) were females; 2 (100%) of the patients who developed urosepsis were males; the rest of the males, 69 (69%), had no urosepsis; females, 31 (31%), also had no urosepsis; no significant association was found between gender and urosepsis (p-value = 0.554). Regarding risk factors for urosepsis, diabetes mellitus was found in 35 (35%) of the patients. One (33%) of the patients with urosepsis was found to be diabetic; there was no significant difference between diabetes mellitus and urosepsis (p-value = 1.000). Fifty-seven (37%) were hypertensive, and only one (33%) of those who were found to have urosepsis were hypertensive; no significant association was found between hypertension and urosepsis (p-value = 1.000). Fourteen (9%) were found to have chronic kidney disease; nine (6%) had cardiovascular diseases; and six (4%) had hematological disorders. Five (3%) had steroid use; there was no difference between the patients using steroids and those with urosepsis (p-value = 1.000). About 41 (41%) had other co-morbidities, and 2 (100%) of those with urosepsis were found to have other co-morbidities. There is no significant association between other co-morbidities and urosepsis (p-value = 0.569). Table 1 shows the demographics and risk factors for all the patients developing urosepsis following PCNL.

Table 1: Demographic data, patients' risk factors, and its association with developing urosepsis following PCNL (n=100)

Variable	Overall	Urosepsis		P-value
		Yes	No	
Age: mean ± SD (range)	49.9 ± 18.5 years (6 – 88)	40.7 ± 31.0	50.1 ± 18.3	0.386T
BMI: mean ± SD	29.3 ± 7.3	18.9 ± 7.8	29.5 ± 7.1	0.012T
Gender: n (%)				
Male	70 (70)	2 (100)	68 (69.4)	0.554
Female	30 (30)	0 (0)	30 (30.6)	
Stone side				
Left		05(5.0)	85 (85.0)	0.525
Right		02 (2.0)	08 (8.0)	

Variable	Overall	Urosepsis		P-value
		Yes	No	
Stone diameter (cm)		3.3 ± 1.8 (1.5–3.8)	2.8 ± 1.4 (1.6–3.9)	0.422
Patient risks factors: n (%)				
Diabetes mellitus	35 (35)	1 (50)	35 (35)	1.000
Hypertension	37 (37)	1 (50)	37 (37)	1.000
Hypothyroidism	2 (2)	0 (0)	2 (2)	1.000
Hematological disorder	4 (4)	0 (0)	4 (4)	1.000
Cardiovascular disease	6 (6)	0 (0)	6 (6)	1.000
Chronic kidney disease	9 (9)	0 (0)	9 (9)	1.000
Steroid use	3 (3)	0 (0)	3 (3)	1.000
Other comorbidities	41 (41)	2 (100)	41 (41)	0.569

T: p-value calculated using independent samples t-test, other p-values calculated using Fisher's exact test.

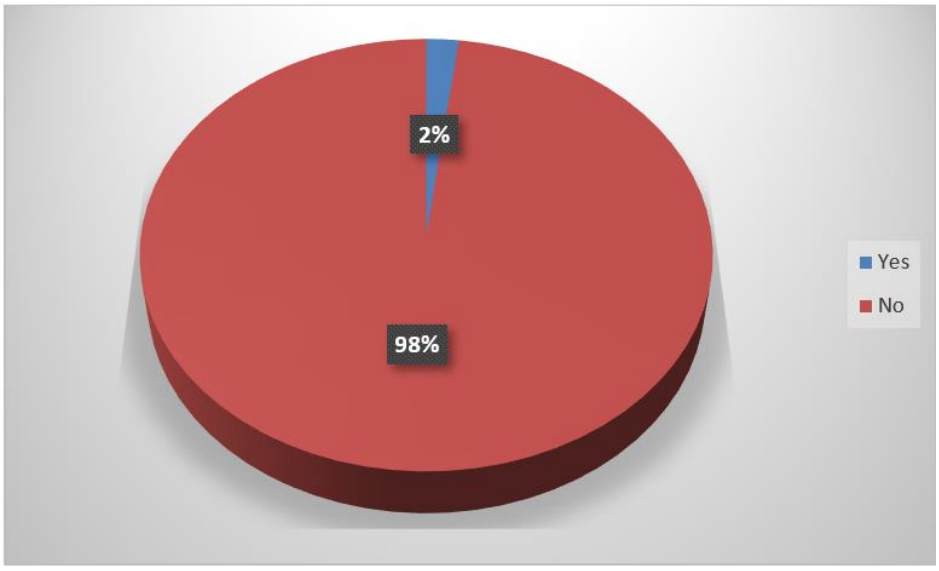

Figure-1: Incidence of urosepsis following percutaneous nephrolithotomy.

Concerning the diagnosis and indication of PCNL, the most frequently reported indication was found to be unilateral renal stones in 75 (75%) patients, and all 3 (100%) of those with urosepsis were found to have unilateral renal stones; staghorn stones were found in 15 (16.8%) patients; 6 (6%) patients had bilateral renal stones; and 7 (7.1%) had ureteric stones. No statistically significant association was found between indications of PCNL and urosepsis (p-value = 0.746).

Table 2: Information of percutaneous nephrolithotomy surgery, hospital course, and data upon discharge and its association with urosepsis (N=100)

Variable	Overall n (%)	Urosepsis		P-value
		Yes	No	
Indications/diagnosis				
Bilateral renal stone	6(6)	0 (0)	7 (7.1)	
Staghorn stone	15 (15)	0 (0)	15 (16.8)	
Unilateral renal stone	75 (75)	3 (100)	70 (72.2)	
Ureter stone	4 (4)	0 (0)	5 (5.1)	0.746
Age at time of surgery (years): mean ± SD	46.4 ± 18.1	37.3 30.3	46.6 17.9	0.384T
Complications	2 (2)	0 (0)	2 (2)	1.000
Previous PCNL	20 (20)	0 (0)	20 (20)	0.612
ICU admission	3 (3)	3 (100)	2 (2)	< 0.001
Length of stay (days): mean ± SD	7.7 ± 11.5	52.3 34.9	6.8 8.8	0.004M
Antibiotic course	41 (41)	3 (100)	40 (41.2)	0.068
Stone analysis				
Calcium oxalate	63 (63)	2 (66.7)	60 (61.8)	
Cystine	6 (6)	0 (0)	6 (6.1)	

Variable	Overall n (%)	Urosepsis		P-value
		Yes	No	
Urate	15 (15)	0 (0)	16 (16.4)	
Calcium oxalate and urate	4 (4)	0 (0)	4 (4.1)	0.089
Calcium oxalate and cystine	2 (2)	1 (33.3)	2 (2.1)	
Calcium oxalate and carbonate	6 (6)	0 (0)	5 (5.1)	
Struvite	4 (4)	0 (0)	4 (4.1)	
Antibiotic upon discharge				
No	29 (29)	1 (33.3)	29 (29.9)	
Bactrim	8 (8)	0 (0)	8 (8.2)	
Cefuroxime	29 (29)	1 (33.3)	28 (28.8)	0.098
Norfloxacin	4 (4)	0 (0)	4 (4.1)	
Nitrofurantoin	3 (3)	1 (33.3)	2 (2.1)	
Ciprofloxacin	27 (27)	0 (0)	26 (26.6)	
Duration of antibiotics (days): mean ± SD	8.4 ± 10.1	16.5 16.3	8.3 10.0	0.524M
ER visit post-op	32 (32)	1 (33.3)	31 (31.9)	1.000
Time of removal of JJ stent				
N/A	26 (26)	1 (33.3)	24 (24.7)	0.748
<1 week	7 (7)	0 (0)	7 (7.2)	
>1 week but <2 weeks	10 (10)	1 (33.3)	10 (10.3)	
>2 weeks	57 (57)	1 (33.3)	56 (57.7)	
Residual stone				
Yes	45 (45)	3 (100)	42 (43.2)	
No	34 (34)	0 (0)	35 (36.1)	0.237
No CT done	21 (21)	0 (0)	20 (20.6)	
Subsequent intervention	38 (38)	2 (66.7)	37 (38.1)	0.558

M: p-values calculated using Mann-Whitney test, T: independent samples t-test, other p-values calculated using Fisher's exact test; PCNL: percutaneous nephrolithotomy; ICU: intensive care unit; ER: emergency room.

The mean age at the time of surgery was found to be 46.4 ± 18.1 years old; the mean age at the time of surgery for patients with urosepsis was found to be 37.3 ± 30.3 years old; and the mean age at the time of surgery for patients with no urosepsis was found to be 46.6 ± 17.9 years old (p-value = 0.384). Complications of PCNL were reported in two (2%) patients; complications were found among those with no urosepsis. Previous PCNL was reported in 20 (20%) patients. 3 (3%) patients were admitted to the ICU; three (100%) of those with urosepsis were admitted to the ICU. ICU admission and urosepsis were found to be significantly associated (p-value < 0.001), with patients with urosepsis being more likely to be admitted to the ICU compared to others. The mean length of stay (in days) was found to be 7.7 ± 11.5 in general; the mean length of stay for those with urosepsis was found to be 52.3 ± 34.9 days; and the length of stay for those with no urosepsis was found to be 6.8 ± 8.8 days. 41 (41%) patients had an antibiotic treatment course; all three (100%) patients with urosepsis were on an antibiotic treatment course; 40 (41.2%) patients with no urosepsis were on an antibiotic treatment course; and no significant association was found between the antibiotic treatment course and urosepsis (p-value = 0.068).

The most frequently reported type of stone in the analysis was found to be calcium oxalate in nearly two- thirds, or 63 (63%), of the patients; urate stones were found in 15 (15 %) patients, cystine, calcium oxalate, and carbonate were found in 6 (6%) patients each; and struvite stones were reported in 4 (4%) patients. Less than one-third, 29 (29%), of the patients had no antibiotics upon discharge, and 1 (33.3%) of those with urosepsis were discharged without antibiotics. About 29 (29%) received cefuroxime, and 1 (33.3%) of those with urosepsis also received cefuroxime; 29 (29.9%) of the patients with no urosepsis have received cefuroxime; 26 (26.6%) of the overall patients received ciprofloxacin; none of those with urosepsis received ciprofloxacin; bactrim was given to 8 (8.2%) patients; and also none of the participants with urosepsis received bactrim; and norfloxacin was used in the treatment of 4 (34.1%) of the patients, and none of the patients with urosepsis received norfloxacin. Nitrofurantoin was used by 3 (3%) of the patients, and 1 (33%) patient with urosepsis received nitrofurantoin in the treatment course. The mean duration of antibiotic treatment among overall patients was found to be 8.4 ± 10.1 days; the mean antibiotic treatment among patients with urosepsis was found to be 16.5 ± 16.3 days; and among those with no urosepsis, it was found to be 8.3-10 days. About 32 (32%) of the overall patients had post-operative ER visits, and 1 (33%) of those with urosepsis had a post-operative ER visit. Time of removal of JJ stent was found to be more than two weeks in 57 (57%) patients, and 1 (33%) of the patients with urosepsis had JJ stent inserted for more than two weeks; about 10 (10%) of the patients

had JJ stent inserted for more than one week but less than two weeks; also, 1 (33%) of the patients with urosepsis had JJ stent inserted for more than one week but less than two weeks; 7 (7%) had a time of removal of less than one week; and time of removal was not found to be significantly associated with urosepsis (p-value = 0.748). Residual stone was found in 45 (45%) patients, and all 3 (100%) of the patients with urosepsis had residual stone; 34 (34%) patients had no residual stone, and 21 (21%) patients had no CT done. More than 38 (38%), of the patients had a subsequent intervention, and 2 (66%) of the patients with urosepsis had a subsequent intervention. Subsequent intervention and urosepsis were not found to be significantly associated (p-value = 558). In Table 2, surgery, hospital course, and post-discharge status were described.

DISCUSSION

In recent years, with the development of minimally invasive technology, the safety and effectiveness of PCNL has improved; however, postoperative infection is still one of the major complications. Studies have shown that the incidence of infectious complications after PCNL surgery is 2.8–32.1% [14]. If postoperative infection is not detected in time and there is no active anti-infective treatment, septic shock can result. Indeed, in different regions and countries, mortality rates for severe sepsis and septic shock vary among medical centers, with reported results ranging from 22 to 76% based on available epidemiological data [15]. Urosepsis refers to sepsis due to urinary tract and/or infections of the male reproductive system [9,16]. In recent years, research on risk factors of urosepsis caused by urinary calculi has increased significantly. A total of 100 patients were included in this study. The mean age of the patients overall was found to be 49.9 ± standard deviation (SD) of 18.5 years (range of 6-88 years). The mean age of the patients with urosepsis was found to be 40.7 ± 31 years old. The mean age of the patients with no urosepsis was found to be 50.1 ± 18.3. About 70 (70%) of the participants were males and 30 (30%) were females; 2 (100%) of the patients who developed urosepsis were males; the rest of the males, 69 (69%), had no urosepsis; females, 31 (31%), also had no urosepsis; no significant association was found between gender and urosepsis (p-value = 0.554). The most frequently reported co-morbidity was found to be diabetes mellitus, which was reported in about one- third (35%) of the participants and one-third (33%) of the participants with urosepsis found to be diabetic, followed by hypertension, which was reported in 37% of the participants and one-third (33%) of those with urosepsis found to also have hypertension, then about 9% were found to have chronic kidney disease, 6% were with cardiovascular diseases and others, and this was consistent with the findings reported in the congruent study conducted by Dimitrijevic *et al.*, in which diabetes mellitus was the most common co- morbidity in patients with urosepsis [17]. Regarding the diagnosis and indication of PCNL, the most commonly reported indication was found to be unilateral renal stones, which were reported in more than two-thirds (74%) of the participants, and all (100%) of those with urosepsis were found to have unilateral renal stones. Complications of PCNL were reported in only 1.3% of the participants. Previous PCNL was reported in about one-fifth (20%) of the participants. The mean length of stay (in days) was found to be 7.7 days, and this was found to be similar to that reported in the parallel study carried out by Hsiao et al., in which the mean length of stay was found to be nine days [18]. Less than half (41%) of the participants had an antibiotic treatment course, and all the participants (100%) with urosepsis had an antibiotic treatment course. The most reported type of stone in the analysis was found to be calcium oxalate in nearly two-thirds (63%) of the participants. Slightly less than one-third (29%) received cefuroxime, and one-third (33.3%) of those with urosepsis also received cefuroxime. About 27% of the overall participants received ciprofloxacin, and none of those with urosepsis received ciprofloxacin. Bactrim was given to 8 (8.2%) of the participants, and none of the participants with urosepsis received bactrim. The previously mentioned antibiotics were the most commonly reported, as found in the other study conducted by Bischoof et al., [19], in which cefuroxime and ciprofloxacin were used, while other antibiotics used included norfloxacin and nitrofurantoin. The mean duration of antibiotic treatment among overall participants was found to be 8.4 days, and the mean antibiotic treatment among participants with urosepsis was found to be 16.5 days. This was found to be consistent with the findings reported in the study conducted by Klara and Raizada, in which the mean treatment course was found to be 17-22 days [20]. The time of removal of the JJ stent was found to be more than two weeks in more than half (57%) of the participants, and 33% of the participants with urosepsis had a JJ stent inserted for more than two weeks, which was found to be consistent with the findings reported in the congruent study carried out by Visser *et al.*, which was carried out three weeks after surgery [21]. But in majority of non-urological cause of urosepsis patients the score was low and there was a rapid decline in number of such patients with rise in the score. This helped surgeons to be more careful specially for high risk patients and avoiding associated complications. Urosepsis following PCNL (Percutaneous Nephrolithotomy) depended on variety of the preoperative and perioperative factors. Earlier reports had identified number and size of tracts, bleeding, surgical time, irritants used, pelvic pressure, nephrostomy care as major factors associated with urosepsis [19-21]. But the surgeons experience and its association with incidence of urosepsis was not clear. Since preoperative factors played an important role in the incidence of urosepsis, the peri and postoperative factors were not included in the meta- analysis used to establish this scoring system. Thus, this evaluation system might not be enough to precisely assess the risk of

postoperative urinary sepsis. The limitations of the study were the fact that the data were collected from one hospital, which restricted the generalizability of the findings. This subject requires more exploration with a bigger sample and the involvement of multiple hospitals in the region to achieve an accurate estimation of the incidence and risk factors for developing urosepsis following percutaneous nephrolithotomy. We had developed a risk assessment system to assess the probability of urosepsis following PCNL (Percutaneous Nephrolithotomy). The clinical application and effectiveness were also validated. The risk assessment system was useful in quantification of the operative risk before surgery could help surgeons timely and accurate appraise the risk of postoperative urosepsis. It also enabled to screen high risk patients and strictly monitor these patients. Thus, this scoring system could identify the risk factors and guide to use appropriate measures to improve the prognosis of PCNL (Percutaneous Nephrolithotomy).

CONCLUSION

The incidence of urosepsis among the patients who underwent PCNL was less than 2%. Diabetes mellitus, followed by hypertension, were the most prevalent co-morbidities among the participants. Cefuroxime was the antibiotic of choice when treating patients and following urosepsis.

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