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Diabetes Mellitus, a Risk Factor for Systemic Inflammatory Response Syndrome in Patients after Percutaneous Nephrolithotomy

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ABSTRACT

Objective: The purpose of this study is to ascertain the prevalence of systemic inflammatory response syndrome in individuals with diabetes mellitus following PCNL. The findings of this study will assist in developing recommendations for these individuals in order to lower their morbidity and SIRS rate. **Study design:** Cohort study. **Settings:** Department of Urology, Madinah Teaching Hospital, Faisalabad. **Study duration:** February to April of 2025. **Materials & Methods:** Total 106 patients between the ages of 18 and 70 with unilateral kidney calculi receiving PCNL were included, regardless of gender. Patients who had received phase II PCNL were excluded, as were those with a history of cancer or hematologic disorders, a preoperative white blood cell count (WBC) of >12 * 109 cells/L or <4 * 109 cells/L, a preoperative basal body temperature of >38°C or <36°C, and a basal heart rate of >90 beats/min. A consultant with three years of post-fellowship experience performed PCNL on the patients under general anesthesia following a single intravenous injection of a preventive antibiotic regimen. SIRS was diagnosed in patients. **Results:** Following percutaneous nephrolithotomy, 17 (16.04%) of the patients in our study experienced systemic inflammatory response syndrome. Eleven (30.56%) of the 36 diabetic patients had SIRS developed, while 25 (69.44%) did not. Diabetes mellitus and SIRS were found to be significantly correlated (p 0.006), with DM patients having a higher odd ratio of 4.69 for SIRS development. **Conclusion:** One of the early side effects of PCNL surgery is SIRS, which can result in sepsis and septic shock, which can lengthen hospital stays, increase morbidity, and potentially increase mortality after the procedure.

INTRODUCTION

A frequent urologic condition, upper urinary calculus has a 1-20% lifetime incidence. Interventions are necessary for stones that do not go away on their own, although the paradigm changed from open surgery to minimally invasive techniques.[1] The gold standard for renal treatment is percutaneous nephrolithotomy (PCNL). Large renal calculi, or stones larger than 2 cm, can be safely and effectively managed using PCNL. Compared to traditional renal stone surgery, this method had a higher success rate, lower morbidity, and fewer complications.[2]

Following PCNL, systemic inflammatory response syndrome (SIRS) is one of the common side effects. This issue is a systemic inflammatory reaction that will cause the body to deteriorate on its own. Both infectious and non-infectious causes can produce this kind of self-destructive harm.[3] Nevertheless, the precise pathophysiological mechanism behind SIRS remains unclear. Urinary sepsis and multiple organ dysfunction syndrome (MODS) can result from poorly managed systemic inflammatory response syndrome, which can endanger patients' lives if left untreated.[4]

In order to screen patients and take preventive action to stop patient deterioration, it is crucial to identify risk factors for SIRS and forecast when it will occur.[5] SIRS is linked to a number of chronic conditions, including diabetes, hydronephrosis, stone burden, length of operation, preoperative urine WBC count, and positive preoperative urine culture. According to studies, SIRS is linked to diabetes following PCNL for upper urinary tract calculi.[6]

In patients with a preoperatively negative urine culture (UC), a study investigated the risk variables for SIRS following percutaneous nephrolithotomy (PCNL). SIRS appeared in 29 patients (12.7%) after surgery. The study comprised 228 patients, 76 of whom were female and 152 of whom were male, with a median age of 48.5 years. It was discovered that 25 patients (11%) had diabetic mellitus (DM). SIRS appeared in 29 patients (12.7%) after surgery. Eight (27.6%) and seventeen (8.5%) of the twenty-five

diabetic patients did not develop SIRS. Diabetes mellitus and SIRS were shown to be significantly correlated (p 0.048), with a higher odd ratio of 3.914 for developing SIRS in DM patients.[7]

Very little research has been done on how postoperative SIRS develops in DM patients. The purpose of this study is to ascertain the prevalence of Systemic Inflammatory Response Syndrome in individuals with diabetes mellitus following PCNL. The findings of this study will assist in developing recommendations for these individuals in order to lower their morbidity and SIRS rate.

MATERIALS AND METHODS

This cohort study was carried out at the Madinah Teaching Hospital's Urology Department in Faisalabad from February to April of 2025. Following institutional ethical review committee approval, non-probability consecutive sampling was used to choose 106 patients who met the inclusion criteria. Every patient will be asked for their informed permission. With a 95% confidence level, a 6.35% margin of error, and a 12.7%[7] frequency of SIRS in patients following PCNL, a sample size of 106 cases has been determined. All patients between the ages of 18 and 70 with unilateral kidney calculi receiving PCNL were included, regardless of gender. Patients who had received phase II PCNL were excluded, as were those with a history of cancer or hematologic disorders, a preoperative white blood cell count (WBC) of >12 * 109 cells/L or <4 * 109 cells/L, a preoperative basal body temperature of >38°C or <36°C, and a basal heart rate of >90 beats/min.

Before being included in the study, each participant gave their informed consent after being informed of its goals and assured of the confidentiality of the data. In accordance with the inclusion criteria, patients were chosen. Age, gender, past medical history, smoking history, kidney calculi size, degree of hydronephrosis, BMI, DM status, operation time, and postoperative blood transfusion were among the clinical and demographic information gathered from the patients. A consultant with three years of post-fellowship experience performed PCNL on the patients under general anesthesia following a single intravenous injection of a preventive antibiotic regimen. Within seven days after surgery, SIRS was identified in patients who satisfied two or more of the following criteria: Body temperature (T) > 38°C or < 36°C; (1) heart rate (P) > 90 beats per minute; (2) respiratory rate > 20 beats per minute, or hyperventilation, arterial blood gas PaCO2 < 232 mm Hg; (3) shortness of breath, WBC > 12 * 109 cells/L or < 4 * 109 cells/L, or immature granulocytes > 10%. A freshly created proforma was used to record all of the data.

The analysis of the data was done with SPSS version 25.0. The mean ± standard deviation was used to characterize quantitative variables such as age, height, weight, BMI, kidney calculi size, and operation time. categorical factors such as DM, SIRS, smoking history, degree of hydronephrosis, postoperative blood transfusion, gender, side of PNL, and stone location. Odd ratios were computed to ascertain the relationship between DM and SIRS, and the chi-square test was used to compare the frequency of SIRs. Stratification was used to account for effect modifiers such as age, gender, BMI, size of kidney calculi, operation time, PNL side, stone location, smoking history, degree of hydronephrosis, and postoperative blood transfusion. To determine their impact on SIRS, the post-stratification chi-square test was used. A P value of 0.05 or less was regarded as significant.

RESULTS

Participants in the study were between the ages of 18 and 70, with an average age of 38.71 ± 11.09 years. The age range of 73 patients, or 68.87% of the total, was 18–45 years old. Of the 106 patients, 60 (56.60%) were men and 46 (43.40%) were women, resulting in a male to female ratio of 1.3:1. The average BMI was found to be 27.55 ± 3.05 kg/m2. 26.17 ± 13.26 minutes was the average operating time. The stone's mean size was 27.58 ± 6.47 mm. The distribution of patients with additional confounding variables is shown in Table 1.

Following percutaneous nephrolithotomy, 17 (16.04%) of the patients in our study experienced systemic inflammatory response syndrome (Figure 1). Eleven (30.56%) of the 36 diabetic patients had SIRS developed, while 25 (69.44%) did not. Diabetes mellitus and SIRS were found to be significantly correlated (p 0.006), with DM patients having a higher odd ratio of 4.69 for SIRS development (Table 2). Table 3 displays the SIRS stratification by age, gender, BMI, kidney calculi size, operation time, PNL side, stone placement, smoking history, degree of hydronephrosis, and postoperative blood transfusion.

Table 1

Distribution of Patients with Different Variables (n=145)

variables		Frequency	%age
Age (years)	18-45	73	68.87
	46-70	33	31.13
Gender	Male	60	56.60
	Female	46	43.40
BMI (kg/m²)	≤30	82	77.36
	>30	24	22.64
Diabetes Mellitus	Yes	36	33.96
	No	70	66.04
Stone size (mm)	≤30	60	56.60
	>30	46	43.40
Operative time (min)	≤30	74	69.81
	>30	32	30.19
Side	Right	50	47.17
	Left	56	52.83
Stone location	Pelvis	40	37.74
	Calyx	50	47.17
	Staghorn	16	15.09
Smoking	Yes	23	21.70
	No	83	78.30
Degree of hydronephrosis	No	32	30.19
	Mild	45	42.45
	Moderate	29	27.36
Post-operative blood transfusion	Yes	24	22.64
	No	82	77.36

Figure 1
Frequency of SIRS in Patients after Percutaneous Nephrolithotomy (n=106).

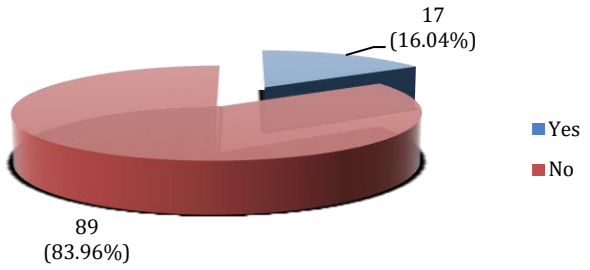

Table 2
Association of Diabetes Mellitus and SIRS in Patients with PCNL.

		SIRS		P-value	OR
		Yes (n=17)	No (n=89)		
Diabetes mellitus	Yes	11 (30.56%)	25 (69.44%)	0.006	4.69
	No	06 (8.57%)	64 (91.43%)		

Table 3
Stratification of SIRS with Respect to Age, Gender, BMI, Kidney Calculi Size, Operation Time, Side of PN, Stone Location, History of Smoking, Degree of Hydronephrosis, Postoperative Blood Transfusion.

Variables		Yes (n=17)	No (n=89)	P-value
Age (years)	18-45	13 (17.81%)	60 (82.19%)	0.460
	46-70	04 (12.12%)	29 (87.88%)	
Gender	Male	09 (15.0%)	51 (85.0%)	0.739
	Female	08 (17.39%)	38 (82.61%)	
BMI (kg/m²)	≤30	13 (15.85%)	69 (84.15%)	0.924
	>30	04 (16.67%)	20 (83.33%)	
Stone size (mm)	≤30	10 (16.67%)	50 (83.33%)	0.869
	>30	07 (17.95%)	32 (82.05%)	
Operative time (min)	≤30	14 (18.92%)	60 (81.08%)	0.219
	>30	03 (9.38%)	29 (90.62%)	
Side	Right	06 (12.0%)	44 (88.0%)	0.284
	Left	11 (19.64%)	45 (80.36%)	
Stone location	Pelvis	04 (10.0%)	36 (90.0%)	0.101
	Calyx	12 (24.0%)	38 (76.0%)	
	Staghorn	01 (6.25%)	15 (93.75%)	
Smoking	Yes	04 (17.39%)	19 (82.61%)	0.841
	No	13 (17.81%)	70 (82.19%)	
Degree of hydronephrosis	No	04 (12.50%)	28 (87.50%)	0.807
	Mild	08 (17.78%)	37 (82.22%)	
	Moderate	05 (17.24%)	24 (82.76%)	
Post-operative blood transfusion	Yes	03 (12.50%)	21 (87.50%)	0.591
	No	14 (17.07%)	68 (82.93%)	

DISCUSSION

The most popular surgical techniques for treating stone disease are endourological procedures. These procedures are more likely to cause infections because they are minimally intrusive (they need to break up the stone) and they need to raise the pressure inside the pelvis (to see better). This is also true for PCNL. Percutaneous nephrolithotomy (PCNL) was first used in the 1970s. It has an overall stone-free rate of 85% to 95%, depending on the size of the stone and how complicated the minimally invasive procedure is (which involves breaking up the stone and raising intra-pelvic pressure to see it). This was a major turning point in the interventional treatment of nephrolithiasis. However, these procedures are more likely to result in infectious complications. Uroepsis is still regarded as a major complication in patients undergoing PCNL, even though urine cultures are regularly conducted prior to urological surgery to assure sterility and that patients with infections were treated with the proper medications. According to several studies, post PCNL SIRS is frequently recorded in 20–30% of patients and can lead to severe sepsis (0–3%), which has a 50–60% death rate.[8-10] Therefore, maintaining low morbidity rates requires avoiding infection-related consequences.[11]

In the study by Rice P et al., 17.6% of persons had SIRS, and in the study by Lotan P et al., 16.7% of people had SIRS. Most studies found that SIRS happened in 12% to 30% of cases. Our study found that 16.04% of people had SIRS, which is similar to what most other studies have found.[12,13] According to international research, the incidence of sepsis after PCNL varies between 0% and 3%. 3.4% of patients had sepsis, and 0.4% experienced septic shock, according to Rice P et al.[12] Nine out of 700 patients (1.3%) experienced severe sepsis, and six of the nine (66%) passed away, according to Wang C et al.[14] Having an ongoing urinary tract infection, chronic renal illness, or any other condition that weakens the immune system are all known risk factors for SIRS and, as a result, sepsis. We didn't include these patients in our research.

As was the case in the majority of related research, no association between the development of SIRS and demographic factors like the patient's age, gender, or surgical side was discovered. Younger age groups had a higher incidence of SIRS, according to Rice P et al., however our investigation did not uncover this correlation.[12,15] The length of the procedure and the requirement for a blood transfusion were factors that our investigation discovered to be strongly linked with SIRS. The risk of SIRS rose with procedure time, and this increase was shown to be substantial. According to Rice P et al[12], extended surgical duration is linked to increased incidence of postoperative sepsis due to a longer duration of elevated intrapelvic pressures, as well as a higher likelihood of irrigant absorption and pyelovenous backflow.

18.5% of renal pelvic urine cultures were positive, according to Rice P et al.[12] In a similar manner, the removed stone shards were cleaned in five successive bottles with sterile saline before being crushed in the fifth container, whose contents were then submitted to C & S as stone. Of the 80 patients, 15 had a positive stone culture, and 11 of them developed SIRS. The organisms that were isolated resembled the organisms found in renal pelvic urine cultures. E. Coli was the most prevalent, followed by Klebsiella and pseudomonas. The bacteriological profile is comparable to that of prior investigations in which E. Coli was the most prevalent bacterium.[16-18]

The risk variables that raise the possibility of post-PCNL SIRS have been studied by numerous researchers. The risk factors for SIRS following PCNL vary from study to study. In a study of 280 individuals, Gonzalez-Ramirez et al.

found that postoperative fever was linked to staghorn stones, body mass index <18.5 kg/m2, hemorrhage, and extended surgical duration.[19] Several studies have shown that the risk factors that led to SIRS after PCNL included being female, having diabetes, having a positive renal pelvic urine culture, having a long operation, having large stones, having a stone culture, having a blood transfusion, having residual stones, and having hydronephrosis.[20,21]

Previous studies[22,23] have shown that urinary tract infections, particularly complex ones, are far more common in DM patients than in non-DM individuals. Following PCNL, DM is an independent predictive factor for SIRS in this study. This is because blood glucose control cannot address the partial immunological weakness of DM patients, which results in a diminished ability to eliminate microorganisms.[24] In DM patients, immune cells (such neutrophils) have reduced phagocytic activity, which also weakens the killing effect on bacteria.[25]

The small number of patients, single-center design, and retrospective nature of this study are some of its shortcomings, which may introduce selection bias. Because the sample size was limited and the positive rate for several bacterial species was low, we couldn't figure out how different types of bacteria affected the risk of post-PCNL SIRS. The measurement procedure may become biased if several imaging modalities are used to assess stone size. The relationship between SIRS and a number of significant parameters, including stone composition and preoperative and postoperative antibiotics, needs more research. A prospective, randomized investigation is also required to confirm the cause-and-effect link between the risk variables and post-PCNL SIRS. Our findings offer the cautions that lead to the development of SIRS following PCNL

CONCLUSION

One of the early side effects of PCNL surgery is SIRS, which can result in sepsis and septic shock, which can lengthen hospital stays, increase morbidity, and potentially increase mortality after the procedure. Since most of the patients will be young or middle-aged, their extended hospital stays and higher rates of morbidity would result in significant financial losses. Diabetes mellitus is therefore one of the key risk variables identified in the study that is both statistically significant and controllable. Therefore, we firmly believe that the best way to lower morbidity and mortality is to monitor all patients receiving PCNL for SIRS and treat them with wide spectrum antibiotics before tapering them to stone and renal pelvic urine culture-specific drugs.

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