

**Original Research Article**

# **A prospective observational study to determine the incidence of perioperative complications during percutaneous nephrolithotomy (PCNL) surgery and the various risk factors predisposing to them**

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## **Abstract**

**Background:** Percutaneous nephrolithotomy (PCNL) is a relatively non-invasive surgical alternative available for the removal of kidney stones. The traditional approach to renal stones was through open surgical procedures that required general anesthesia and a long convalescence. Although PCNL is a minimally invasive technique, it carries a potential risk of complications. These include bleeding, anemia, hypotension, hyponatremia, hypothermia, injury to vital organs like pleural tear bowel perforation, infection, and septic shock. PCNL is a very common surgery that is being carried out in our institution. However, to date there has been no study on the profile of complications that have been observed perioperatively. In literature, though the listed complications do not quantify their incidence.

**Aim of the study:** To assess the perioperative anesthetic complications of Percutaneous Nephrolithotomy (PCNL).

**Materials and methods:** Data was collected on 60 patients who underwent elective PCNL surgery at Venkateswara Hospital, Nandanam. This included monitoring of blood pressure, heart rate, nasopharyngeal temperature, saturation, end-tidal carbon-di-oxide, arterial blood gas (ABG), the

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volume and temperature of irrigation fluid, the temperature in the operating. The collected data was analyzed to find out the complications that occur during the procedure and to determine their incidence and risk factors associated with them.

**Results:** A total of 60 patients were studied of whom 42 were females and 18 males. 40 patients were ASA grade 1 and 20 were ASA grade 2. The incidence of hypothermia and acidosis was 60% and 26.7%, respectively. The incidence of hypothermia and temperature of the irrigating fluid had a statistically significant association with a p-value of 0.026. The incidence of acidosis was significantly associated with the volume of irrigating fluid with a p-value of 0.025. The risk of acidosis was increased with hypothermia (p-value 0.02 and OR 7.00).

**Conclusion:** The most common complication observed intraoperatively was hypothermia, followed by acidosis and sepsis. Other complications that occurred were excessive bleeding and hydrothorax. Electrolytes imbalance and cardiovascular changes were not observed as major complications. The most significant risk factor associated with hypothermia was found to be perioperative complications; percutaneous nephrolithotomy (PCNL) surgery the usage of cold irrigating fluid.

## Key words

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Clavien score, Complications, Percutaneous, Nephrolithotomy.

## Introduction

Urinary calculi are solid particles in the urinary system. They may cause pain, nausea, vomiting, hematuria, and, possibly, chills and fever from secondary infection. Diagnosis is based on urinalysis and radiological imaging, usually non-contrast helical CT. Treatment is with analgesics, antibiotics for the infection, and, sometimes, extracorporeal shock wave lithotripsy or endoscopic procedures. About 1/1000 adults are hospitalized annually in the US because of urinary calculi, which are also found in about 1% of all autopsies [1]. Up to 12% of men and 5% of women will develop a urinary calculus by age 70. Calculi vary from microscopic crystalline foci to calculi several centimeters in diameter large calculus, called staghorn calculus, can fill an entire renal calyceal system. About 85% of calculi in the US are composed of Ca, mainly Ca oxalate. 10% are uric acid; 2% are cystine, and the remainder is Mg ammonium phosphate (struvite) [2]. Urinary calculi may remain within the renal parenchyma or renal pelvis or be passed into the ureter and bladder. During the passage, calculi irritate the ureter and may become lodged, obstructing urine flow and causing hydroureter and sometimes hydronephrosis [3]. Common areas of lodgment include the ureteropelvic junction, the distal ureter (at the

level of the iliac vessels), and the ureterovesical junction. Typically, a calculus must have a diameter > 5 mm to become lodged. Calculi ≤ 5 mm are likely to pass spontaneously [4]. Even partial obstruction causes decreased glomerular filtration, which may persist briefly after the calculus has passed. With hydronephrosis and elevated glomerular pressure, renal blood flow declines, further worsening renal function [5]. Generally, however, permanent renal dysfunction occurs only after about 28 days of complete obstruction. Secondary infection can occur with long-standing obstruction, but most patients with Ca-containing calculi do not have infected urine [6]. Even large calculi remaining in the renal parenchyma or renal pelvis are usually asymptomatic unless they cause obstruction. Symptoms, such as severe pain, often accompanied by nausea and vomiting, and sometimes gross hematuria, usually occur when calculi pass into the ureter, cause obstruction, or both. Pain (renal colic) is of variable intensity but is typically excruciating and intermittent, often occurs cyclically, and lasts 20 to 60 min. Nausea and vomiting are common [7]. Pain in the flank or kidney area that radiates across the abdomen suggests upper ureteral or renal pelvic obstruction. Pain that radiates along the course of the ureter into the genital region suggests lower

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ureteral obstruction. Suprapubic pain along with urinary urgency and frequency suggests a distal ureteral, ureterovesical, or bladder calculus [8].

## Materials and methods

A prospective cohort study was conducted on 60 patients who underwent elective PCNL surgery at Venkateswara Hospital, Nandanam, This included monitoring of blood pressure, heart rate, nasopharyngeal temperature, saturation, end-tidal carbon-di-oxide, arterial blood gas (ABG), the volume and temperature of irrigation fluid, the temperature in the operating. The collected data was analyzed to find out the complications that occur during the procedure and to determine their incidence and risk factors associated with them.

**Inclusion criteria:** All ASA Grade 1 and Grade 2 patients aged between 18 and 65 years undergoing elective PCNL surgery at a tertiary care center.

**Exclusion criteria:** Any patient age <17 yrs or >65 years or falling into ASA grade 3, 4, 5 or undergoing another procedure along with PCNL.

Intraoperative monitoring of blood pressure, heart rate, nasopharyngeal temperature, saturation, end-tidal carbon-di-oxide were done. These were observed before and during the procedure till the end of the surgery. A baseline arterial blood gas (ABG) sample was collected before the start of the procedure for comparison of any changes that would occur postoperatively. Intraoperatively, the volume and temperature of the irrigation fluid used were noted. The temperature in the operating room was also be noted during the procedure. At the end of the surgery, patients' temperature was noted and a repeat ABG sample was collected. Changes in hematocrit, electrolytes, and lactates from baseline were noted to assess blood loss, dilutional anemia, dilutional hyponatremia, and acidosis.

## Statistical analysis

Data entry was done using the Statistical Package for the Social Sciences (SPSS) software package (version 16). Data were presented as mean  $\pm$  standard deviation, frequency percentages, or median and range. Descriptive statistics were calculated using SPSS software. Univariate analysis was performed between categorical variables using the Chi-square test. Confidence intervals (CI) were calculated. Continuous variables were compared using a T-test. The odds ratio (OR) was presented as a measure of risk. All reported values were two-sided and an 'a value less than 0.05 was considered statistically significant. All patients were brought into the operating room and a wide-bore peripheral intravenous access was established. After preoxygenation, all patients were induced with 5mg/kg body wt of thiopentone, 2mg/kg body wt of fentanyl, and 1mg/kg body wt of vecuronium. Intubation was done using appropriate size cuffed oral endotracheal tubes and fixed after confirming equal air entry. Anesthesia was maintained using a 50-50 mixture of air-O<sub>2</sub> and isoflurane. Intra-operative analgesia was using morphine upto 0.15mg/kg body wt. Fluid management was guided by fasting and maintenance requirements, the patient's vital signs, and the attending anesthetist's assessment of blood loss. At the end of the procedure, anesthetic gases were discontinued, and the patient was reversed with neostigmine and glycopyrrolate and extubated.

## Results

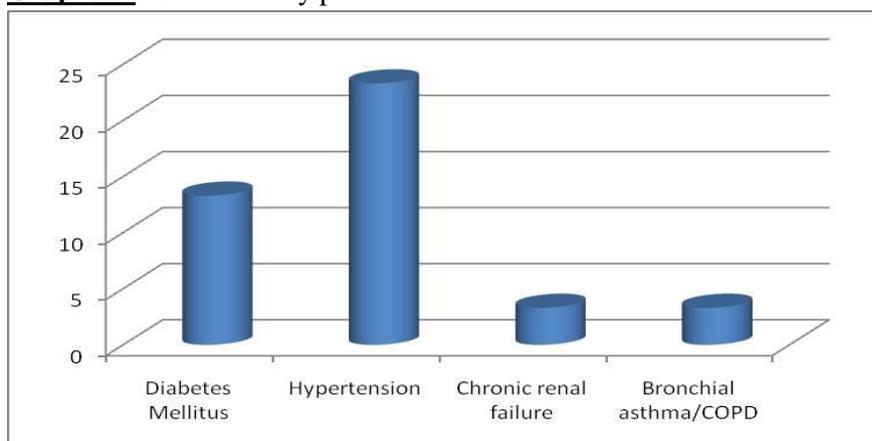
The mean age of the population studied was 39.90 years with a standard deviation of  $\pm$ 10.53 years. The patients ranged from a minimum age of 15 years to a maximum age of 65 years. Of the 60 patients in the study, 18 were females (30%) and 42 were males (70%) The mean baseline blood pressure was 86.27 mmHg with an standard deviation of 16.14 mmHg and the mean baseline heart rate was 82.27 bpm with an standard deviation of 16.48 bpm. The mean baseline temperature was 36.08 degrees Celsius with a standard deviation of 0.41degree Celsius. The mean hematocrit was 38.38 % with a

standard deviation of 7.68%. The mean duration of surgery was 2.30 hours with a standard deviation of 0.83 hours. The mean volume of intravenous fluid used was 1.52 liters with a standard deviation of 0.84. The volume of irrigating fluid used ranged from 6 liters to 84 liters with a median value of 24 liters.

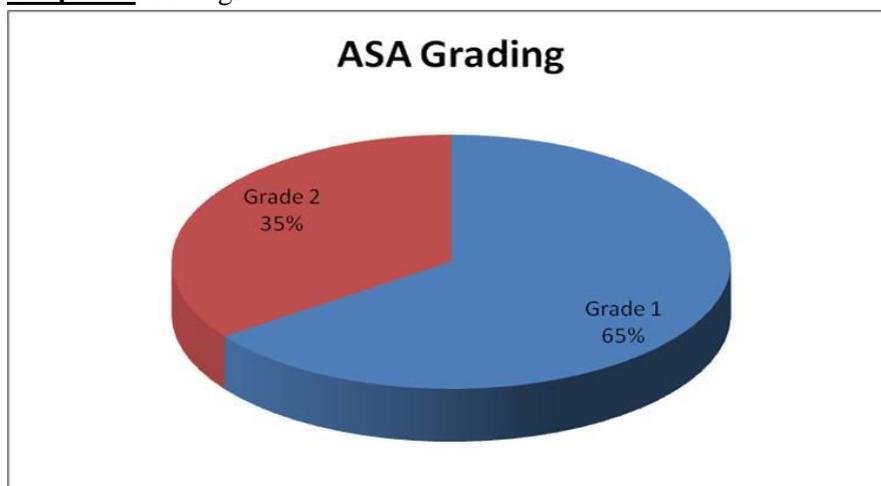
40 out of 60 patients (66.7%) had no comorbid conditions existing. The most common

comorbid condition present was hypertension with 14 out of 60 patients (23.3%). The others were Type 2 Diabetes Mellitus 8 out of 60 (13.3%), chronic renal failure, and bronchial asthma/COPD both with a prevalence of 3.3% (2 out of 60). None of the patients had Ischemic heart disease. 16 patients had only one comorbid illness while 4 patients had multiple comorbid illnesses (presence of 2 or more than 2 comorbid illnesses) existing (**Graph – 1**).

**Graph – 1:** Co-morbidity profile.



**Graph – 2:** ASA grade.



40 patients were categorized as ASA grade 1 while 20 patients belonged to ASA grade 2 (**Graph – 2**).

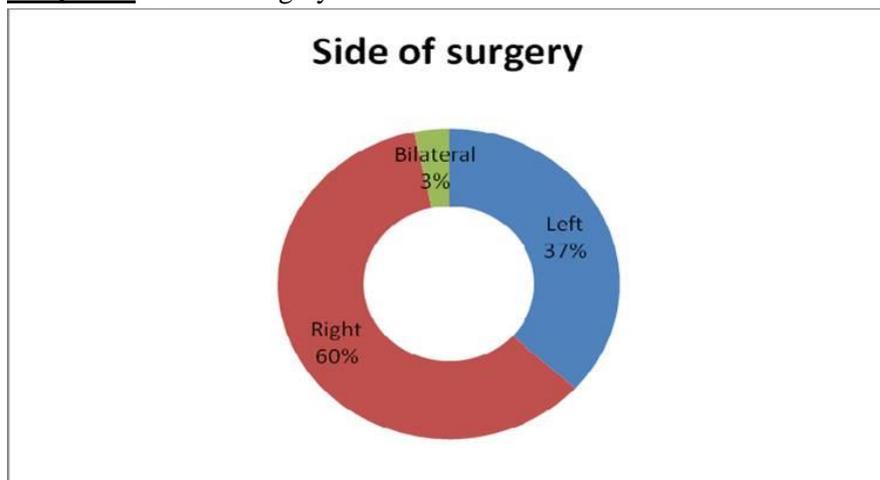
Of the 60 patients who underwent PCNL surgery, 22 patients underwent left-sided surgery, 36 underwent right-sided surgery while 2 patients underwent bilateral surgery (**Graph – 3**).

16 out of 60 patients were diagnosed to have staghorn calculus (**Graph – 4**).

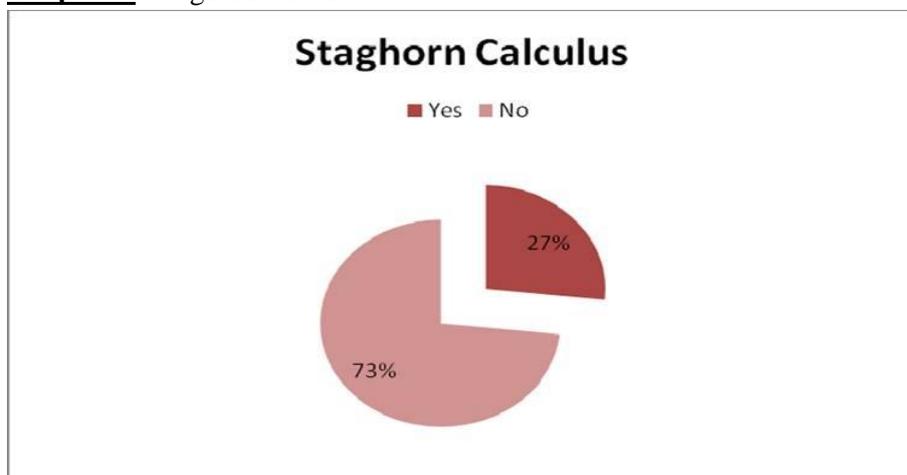
The irrigating fluid was warmed and used in 72% of the cases (43 out of 60), while cold irrigating fluid was used in 28% of the cases (17 out of 60 patients) as per **Graph – 5**.

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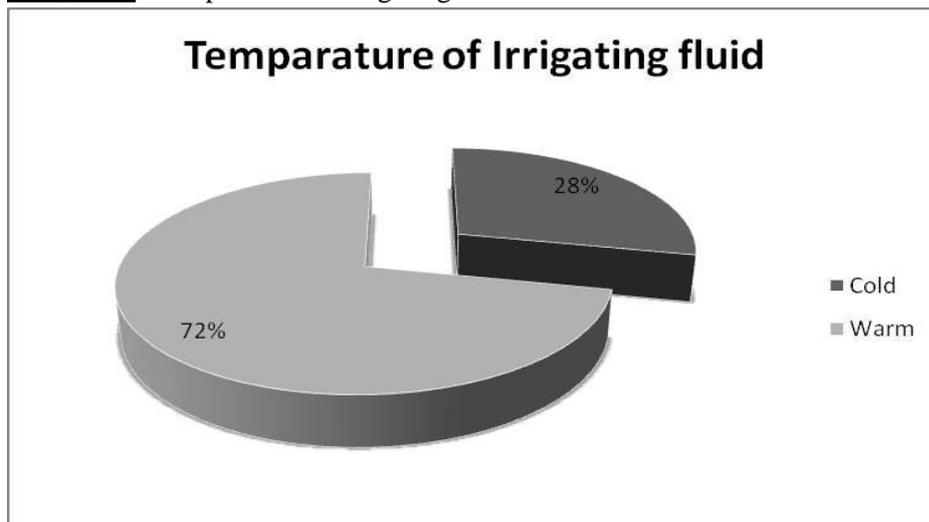
**Graph – 3:** Side of surgery.



**Graph – 4:** Staghorn calculus.



**Graph – 5:** Temperature of irrigating fluid.



Of those who had intraoperative hypotension, the majority of patients, 56.7% (34 of 60) had hypotension after induction till the time of

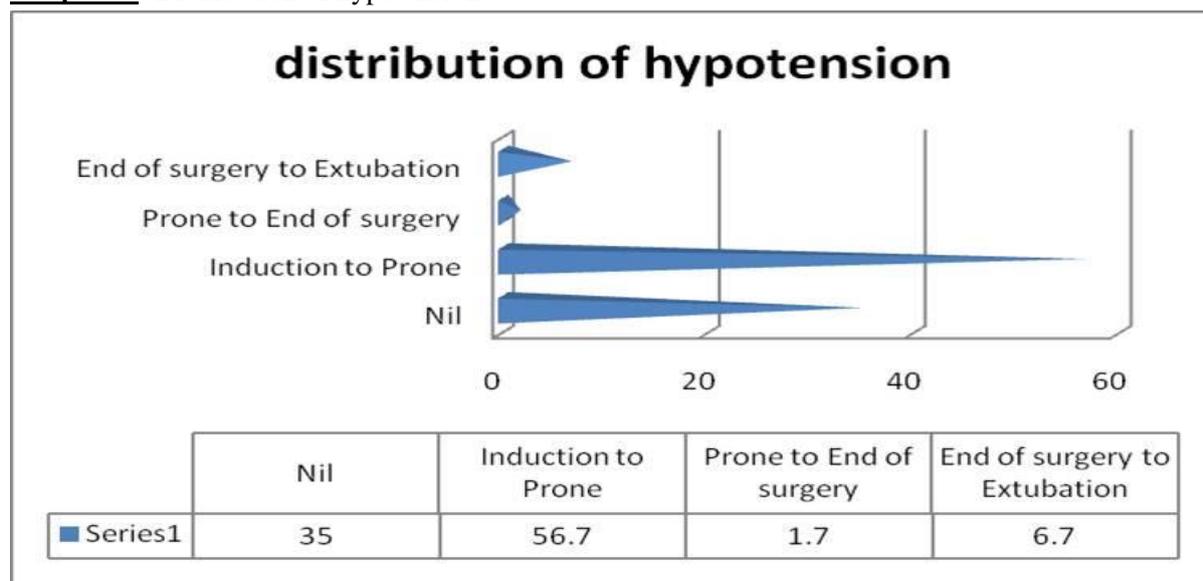
turning prone. Only 1 patient had hypotension lasting through the duration of the surgery. 4 patients had hypotension even after the surgery

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was over till the time of extubation. The most common complication that occurred intraoperatively was noted to be hypothermia with 60% (36 out of 60) of patients becoming hypothermic during the surgery. The next most common complication was acidosis with 16 out of 60 patients (26.7%) observed to be acidotic by the end of the surgery. Of 2 patients who had

Chronic Renal Failure, 1 developed intraoperative hypothermia while the other did not. As such, the results were not statistically different (p-value 0.76). Of 8 patients who had Diabetes, only 3 developed intra-operative hypothermia. With a p-value of 0.163, this association was not significant (**Graph – 6**).

**Graph – 6:** Distribution of hypotension.



**Table – 1:** Hypothermia and duration of surgery.

	Hypothermia		P-value
	Present	Absent	
Duration of surgery (hours)	2 hrs 45 min	2 hrs 6 min	.077

The mean duration of surgery in those patients who developed hypothermia was 2.45 hrs as compared to 2.06 hrs in those who did not. With a p-value of 0.077, this was not significant. Of 36 patients who developed hypothermia, 22 patients had been irrigated with cold fluids. Of the 24 patients who were irrigated with warm fluid, only 3 developed hypothermia. With a p-value of 0.026 and an Odds Ratio (OR) of 0.22, this result was statistically significant; indicating that the risk of hypothermia was increased when cold irrigating fluid was used as opposed to warm fluid. There was no statistically significant difference in the awakening time between those who had hypothermia and those who did not (P-value 0.82). Though the total volume of

Intravenous fluids administered was higher in those who developed hypothermia when compared to those who did not, this observation was not statistically significant (p-value 0.148). Of the 2 patients who had CRF, 1 patient developed acidosis, while the other did not. With a p-value of 0.45, this association was not significant. The mean volume of irrigating fluid was significantly higher in those patients who developed acidosis (33.5 liters), as compared to those who did not develop acidosis (24.4 liters). This result was statistically significant (p-value 0.025). The incidence of sepsis was significantly higher in those patients who had Diabetes Mellitus as a risk factor. With a p-value of 0.026, this result was statistically significant, with an

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Odds Ratio of 8.3 indicating an increased risk of sepsis-associated with Diabetes. There was no significant association between the size of the renal calculi and the incidence of sepsis. The mean stone size was around 2.5 cm in both groups (p-value 0.59). There was no statistically significant association between the incidence of blood transfusion and the size of the calculi (p-value : 0.55) (Table – 1).

## Discussion

In the current day practice, Percutaneous Nephrolithotomy (PCNL) is a very common treatment option available in the management of renal stones. Compared to the earlier treatment option of open surgery, it is associated with a fewer number of complications [9]. This leads to lesser rates of morbidity and lesser hospital stay, and thus is preferred to open surgery. However, the PCNL procedure is not without its own set of complications. All these complications, though listed out in the literature, have not very well been quantified. In our institution, which is a tertiary care center hospital, an average of 25 PCNL surgeries is being done every month [10]. In this scenario, we felt it would be worthwhile to know the profile of complications and factors associated with them. This would help to institute appropriate measures to try and limit their incidence and thus provide better quality health care [11]. In our study, a total of 60 patients who underwent elective PCNL surgery was studied. The majority of patients were ASA grade 1 and there was a predominance of males in the study [12]. In our study the most common intraoperative complication encountered was hypothermia and the second most common complication was acidosis. 60% of our patients were documented to have hypothermia and 26.7% of the patients had acidosis as evidenced by an Arterial Blood Gas at the end of the procedure. Earlier studies have not found hypothermia or acidosis as a major complication [13]. Lee WJ, et al. presented a total complication rate of up to 83% following PCNL, in which hypothermia or acidosis did not feature at all. They presented their findings as major and

minor complications, of which minor complications were more common. Bleeding requiring transfusion was listed as the most common complication. Others included significant bleeding, pain, and fever [14]. In our study, we found hypothermia to be the most common complication that occurred during PCNL surgery. Our study had a 60% incidence of hypothermia. We found a statistically significant positive correlation between the presence of hypothermia and the temperature of irrigating fluid used [15]. We also observed that there was a correlation between the volume of irrigating fluid used and the duration of surgery with hypothermia. However, these values were not statistically significant which could be due to the small sample size studied. 2 children had hypothermia. In our study, the mean duration of surgery was 150 minutes (2.30 hrs) [16]. We also compared the incidence of hypothermia with the ambient temperature in the operating room. The mean ambient temperature in the operating room in our study was 22.6°C. However, we found no positive correlation between the two. This could probably be because we took adequate measures to cover the patient well soon after induction of anesthesia to prevent losing body temperature to the environment [17]. We also used forced-air warming devices. Despite this, the single most important factor that contributed to patients developing hypothermia was the use of cold irrigating fluids. We also compared the presence of hypothermia and the volume of intravenous fluid used. There was no positive correlation. The presence of CRK or DM also did not seem to add any further risk to the development of hypothermia. Even though hypothermia is known to delay awakening from anesthesia, in our study we found no positive correlation between the two. One reason for this could be the timelines set for assessing time to awaken after the discontinuation of anesthetic gases [18]. In our study, we analyzed the incidence of sepsis concerning the presence of DM preoperatively. We found that the presence of DM had a positive correlation to the incidence of sepsis. The presence of DM tends to increase the risk of developing sepsis (Odds Ratio 8.3). On analysis

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of the incidence of sepsis concerning the presence of CRF preoperatively, we found a significant relationship between the two with the presence of CRF increasing the risk for perioperative development of sepsis (OR 28) [19]. Splenic laceration and bowel perforation are other visceral organ injuries listed as major complications of the PCNL procedure in literature. In our study, none of the patients had any visceral organ injury. Splenic laceration has been reported to be very rare after PCNL surgery and is reported to have increased likelihood after a 10<sup>th</sup> rib supracostal puncture. The incidence of bowel perforation, namely colonic injuries has been reported to be 0.3%-0.8% [20].

## Conclusions

The most common complication observed intraoperatively was hypothermia, followed by acidosis and sepsis. The most significant risk factor associated with hypothermia was found to be the usage of cold irrigating fluid. The presence of hypothermia and increased use of intravenous Normal Saline contributed to a higher incidence of acidosis. Electrolytes imbalance and cardiovascular changes were not observed as major complications. An increased incidence of sepsis was seen in the presence of Diabetes Mellitus adrenal insufficiency.

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