Nephro-Urol Mon. 2024 May; 16(2): e144766. https://doi.org/10.5812/numonthly-144766.

Published online: 2024 May 28. **Research Article**

# The Effect of Antibiotic Therapy Before Percutaneous Nephrolithotomy on the Frequency of Postoperative Complications: A Retrospective Cross-Sectional Study

Ali Bonyad [1], Siavash Falahatkar [1], Maziyar Bamdad Soofi [1], Alireza Jafari [1,*]

[1] Urology Research Center, Razi Hospital, School of Medicine, Guilan University of Medical Sciences, Rasht, Iran

[*] *Corresponding author:* Urology Research Center, Razi Hospital, School of Medicine, Guilan University of Medical Sciences, Rasht, Iran. Email: dr.alireza.jafariii@gmail.com

**Received** 2024 January 10; **Revised** 2024 February 28; **Accepted** 2024 April 27.

## Abstract

**Background:** Percutaneous nephrolithotomy (PCNL) is commonly used in the treatment of large renal stones. Postoperative infections are a common consequence of these procedures.

**Objectives:** The purpose of this study is to evaluate the effects of antibiotic therapy before PCNL on the possibility of developing fever and common complications after the procedure.

**Methods:** We carried out a retrospective cross-sectional study involving 708 patients who had undergone PCNL at Razi Hospital in Rasht, covering the period from 2012 to 2022. Patients were allocated into two groups: Group 1 included 454 patients who had received antibiotic therapy, and group 2 included 254 patients who had not received pre-operative antibiotic therapy.

**Results:** In group 1, there were 241 males (53.1%) and 213 females (46.9%), while in group 2, there were 138 males (54.3%) and 116 females (45.7%). In group 1, 82.7% of patients treated with antibiotics had a negative culture. The hospitalization time was 4.00 ± 1.75 days for group 1 and 2.26 ± 1.56 days for group 2. Fever was observed in 39 patients (11.2%) in group 1. Sepsis was seen in only one patient (0.3%) in group 1. There is a significant relationship between total hospitalization time (P = 0.000), hospitalization after the operation (P = 0.000), hypertension (P = 0.009), ischemic heart disease (P = 0.050), history of shock wave lithotripsy (P = 0.003), hydronephrosis (P = 0.000), age (P = 0.004), and hemoglobin levels (P = 0.000) with antibiotic therapy.

**Conclusions:** Surgeon overprescription of antibiotics may lead to resistance, complicating outcomes and extending hospital stays after PCNL. Some complications remain unaffected by antibiotic therapy due to surgical experience.

*Keywords:* Percutaneous Nephrolithotomy, Antibiotic Therapy, Complications, Kidney Stone, Fever

## 1. Background

Percutaneous nephrolithotomy (PCNL) is a highly effective procedure for removing renal calculi, particularly in patients with large or complex stones (1, 2). Introduced in 1976, PCNL has evolved significantly with advancements in operative techniques and endoscopic equipment, leading to higher success rates and reduced complications (2, 3). Renal stone disease, treated by PCNL, affects 5 - 15% of the worldwide population and has a notable tendency to recur, with 50% of cases recurring within 5 - 10 years and 75% within 20 years (4). Despite its effectiveness, PCNL can lead to postoperative complications (5).

Postoperative urinary tract infections (UTIs) and fevers are common after PCNL, affecting up to 39.8% of patients (6-8). Post-PCNL fevers are usually transient, but some patients can develop sepsis, which is a serious condition (9, 10). The pathogenesis of UTIs after PCNL appears to begin with the release of bacteria from surgical manipulation, fragmentation of calculi, and/or via the nephrostomy tract (11).

Furthermore, the risks increase with factors such as pre-operative urinary infections, prolonged surgery, surgeon expertise, certain patient characteristics (such as diabetes and obesity) (12-14), prior PCNL procedures, and intraoperative factors including average renal pressure sustained during PCNL, operative time, number of tracts, and degree of blood loss (11, 12). A positive renal pelvis urine culture is also considered a significant risk factor for post-PCNL fever (15). The associations between these factors and the risk of post-

PCNL UTIs are largely inconsistent across studies (16). Recently, it has become known that antibiotic therapy was unsuccessful in eliminating the risk of infection (17).

## 2. Objectives

The current investigation aims to explore the role of antibiotic therapy in developing post-operative complications, especially fever, among PCNL patients.

## 3. Methods

We carried out a retrospective cross-sectional study involving 708 patients who had undergone PCNL at Razi Hospital in Rasht, covering the period from 2012 to 2022. The study was approved by the hospital's Ethical Committee (IR.GUMS.REC.1399.081). In this study, 708 patients who underwent PCNL were divided into two groups: Group 1 consisted of 454 patients with prior antibiotic therapy experience, while group 2 comprised 254 patients without pre-operative antibiotic treatment. Patients included in the study had received antibiotic therapy for UTIs two weeks before undergoing PCNL. Furthermore, patients who had a negative urine culture two weeks prior to PCNL did not receive any antibiotics. Patients who presented with pre-operative fever, a positive urine culture, were under 16 years old, or had nephrostomy tubes were excluded from the study.

Before the operation, routine physical examination and investigations of PCNL patients were done by a urology resident. Pre-operative and intraoperative information of PCNL patients, including age, sex, weight, BMI, hemoglobin, creatinine, glomerular filtration rate (GFR), history of stone surgery, degree of hydronephrosis, pre-operative antibiotic therapy, number, location, and size of the stones, types of staghorn stones, surgery time, residual fragments, hospitalization, and underlying disease were recorded. The risk factors of PCNL patients, such as a history of extracorporeal shock wave lithotripsy (ESWL), history of renal transplant, history of ureteroscopy (URS), ischemic heart disease (IHD), hypertension (HTN), and diabetes mellitus (DM), were also recorded.

Next, ultrasound examinations of the kidneys and bladder were done. Kidneys, ureters, bladder x-ray (KUB), and intravenous pyelogram (IVP) were performed. In some patients with unclear urinary tract anatomy, computed tomography (CT) with contrast enhancement was performed. Regardless of patients' positive or negative urine culture, a single dose of prophylactic antibiotics was prescribed at the beginning of anesthesia, according to the standard treatment protocol. Postoperative hemoglobin, creatinine, GFR, and hospitalization time after the operation were collected.

In this study, fever was defined as a temperature less than 36 °C or greater than 38 °C, a heart rate greater than 100 beats/min, a respiratory rate greater than 20 breaths/min or $PaCO_2$ lower than 32 mm Hg, and a white blood cell (WBC) count greater than $12 \times 10^9$ / L or less than $4 \times 10^9$ / L (18).

All patients underwent a mid-urine exam at admission. Any bacterial growth greater than 100,000 was regarded as a positive urine culture (infected urine). After data cleaning, the data were entered into a Microsoft Excel spreadsheet and then transported into SPSS (IBM, IL, USA) for statistical analysis. Descriptive statistics (mean, standard deviation, minimum, maximum, numbers, and percentage) were calculated for variables. Analytical statistics were done to find the relations between variables with a P-value $< 0.05$ considered significant. The Shapiro-Wilk test was used to determine the normality of the quantitative variables in the present study.

## 4. Results

The study encompassed two distinct patient groups. Group 1 included 454 individuals, comprising 241 males (53.1%) and 213 females (46.9%), while group 2 consisted of 254 participants, with 138 males (54.3%) and 116 females (45.7%). The average age of patients in group 1 was 49.11 ± 12.51 years, and in group 2, it was slightly higher at 51.65 ± 12.23 years. Body Mass Index (BMI) was also recorded, revealing an average of 27.73 ± 4.94 in group 1 and 28.33 ± 4.65 in group 2. This resulted in a prevalence of overweight status in 174 (41%) patients in group 1 and 111 (45.3%) in group 2. The mean serum hemoglobin and creatinine (pre-operative and post-operative) levels in the two groups are shown in Table 1. The history of stone surgery in patients is also detailed in Table 1. As shown in Table 1, pelvic stones were diagnosed in 66 (14.8%) patients in group 1 and 40 (16.4%) patients in group 2. In this study, 20 (33.9%) patients in group 1 also had partial staghorn stones. Findings showed that the duration of surgery in group 1 and group 2 were 45.48 ± 18.44 minutes and 46.15 ± 18.01 minutes, respectively (Table 1). The hospitalization time for patients undergoing PCNL was 4.00 ± 1.75 days for group 1 and 2.26 ± 1.5 days for group 2. We found that 34 (7.6%) patients in group 1 and 15 (6%) patients in group 2 had at least one residual fragment larger than 4 mm (Table 1). A significant portion of patients had a history of ESWL, with 178 (39.2%) in group 1 and 100 (39.4%) in

group 2. Hypertension was observed in 147 (32.4%) patients in group 1 and 84 (33.1%) in group 2, while DM was present in 77 (18%) and 47 (18.7%) patients in the respective groups. Postoperative complications were noted in 123 (27.2%) patients in group 1 and 32 (12.6%) in group 2. A notable observation was the occurrence of fever above 38°C in 39 (11.9%) patients in group 1 and sepsis in one patient (0.3%) in the same group. Fever was also observed in 10 (4.8%) patients in group 2. The current study showed that there is a significant relationship between total hospitalization (P = 0.000) and hospitalization after the operation (P = 0.000) with antibiotic therapy (Table 2). In terms of underlying diseases, a significant statistical relation was seen between patients with HTN (P = 0.009), IHD (P = 0.050), history of ESWL (P = 0.003), and antibiotic therapy (Table 3). Additionally, there was a significant statistical relationship in postoperative complications between hydronephrosis and antibiotic therapy (P = 0.000) (Table 3). Findings show that there was a significant statistical relation between the means of age (P = 0.004) and hemoglobin (P = 0.000) with antibiotic therapy (Table 2) (Figure 1).

## 5. Discussion

Our study compares two patient groups undergoing treatment for kidney stones. Group 1 received antibiotic therapy and had a slightly younger average age and lower BMI than group 2, who did not receive antibiotic therapy. Both groups had more males than females, and a significant number of patients were overweight. The prevalence of pelvic stones and partial staghorn was noted, with surgery and hospitalization durations recorded. A considerable number of patients had histories of ESWL treatment. Hypertension and DM were common comorbidities. Postoperative complications were higher in group 1, with a few cases of fever and sepsis. Significant statistical relationships were found between hospitalization durations, certain diseases, and antibiotic therapy. The study emphasizes the impact of age and hemoglobin levels on antibiotic therapy effectiveness.

Post-operative complications are one of the main risk factors in patients undergoing PCNL surgery (19). These complications, such as fever, sepsis, extravasation, and transfusion, could be significantly associated with mortality and impose a high cost on the patient (20). Previously, antibiotic therapy seemed an excellent procedure to prevent postoperative complications, especially fever and sepsis (13). However, in some conditions, patients may have antibiotic therapy experience without a UTI or with a negative urine culture (13). The current study shows that 11.2% of the patients who had antibiotic therapy experienced a post-operative fever. Interestingly, only 4.8% of patients without antibiotic therapy experienced a post-operative fever. The prevalence of postoperative fever was higher in patients who received antibiotic therapy than in those who did not before surgery. Additionally, sepsis was seen in only one case (0.3%) of patients who had previously received antibiotic therapy. In total, 27.1% of patients who received antibiotic therapy showed at least one postoperative complication, such as fever, extravasation, transfusion, or sepsis. In comparison, only 12.6% of patients who did not have antibiotic therapy showed post-operative complications. These results indicate that antibiotic therapy before surgery may play a lesser role in minimizing complications after surgery, such as fever or sepsis. These findings can be related to surgeon experience.

Schilling et al.'s study revealed that novice surgeons performing minimally invasive PCNL had longer operative times and higher complication rates than experts (21). A study conducted on 580 patients undergoing PCNL identified factors significantly correlated with postoperative severe sepsis, including stone size >25 mm, prolonged operative time >120 min, and significant bleeding requiring transfusion. It is suggested that surgeon experience could minimize these risk factors, potentially reducing the rates of fever and severe sepsis (22). Another investigation assessing pediatric PCNL outcomes over 20 years demonstrated that increased surgeon experience was associated with improved outcomes, including increased stone-free rates and reduced operation time, blood loss, and complication rates such as fever in pediatric patients (23).

There were some limitations in this study. In the current research, some patients refused to provide accurate answers and gave unrealistic responses. This research was conducted cross-sectionally over 10 years. For this reason, it is challenging to conclude causality. This research was conducted on patients with kidney stones at Razi Hospital, Rasht, who underwent PCNL, and therefore, it cannot be generalized to the entire population.

We know most early postoperative fever is caused by the inflammatory stimulus of tissue damage and exposure to physiological fever during surgery. Starting on postoperative day 4, infections related to the surgical procedure are more common. We do not always assume that fever is due to infection. In fact, for many conditions of patients, the presence of fever may be variable. We excluded immunocompromised patients,

**Table 2.** Complication of Quantitative Variable Post-Operative Percutaneous Nephrolithotomy (PCNL) in Patients with/Without Antibiotic Therapy [a]

| Variables | Antibiotic Therapy | | P-Value [b] |
|---|---|---|---|
| **Yes (n = 454/ Group 1)** | **No (n = 254/ Group 2)** | | |
| **Age** | | | 0.004 [c] |
| With | 48.41 ± 13.3 | 48.81 ± 10.46 | 0.998 |
| Without | 49.33 ± 12.15 | 51.97 ± 12.38 | 0.005 [c] |
| **Hemoglobin (g/dL)** | | | 0.000 [c] |
| With | 10.48 ± 1.86 | 11.22 ± 2.24 | 0.097 |
| Without | 11.95 ± 1.6 | 12.55 ± 1.69 | 0.000 [c] |
| **Serum creatinine (mg/dL)** | | | 0.060 |
| With | 1.14 ± 0.36 | 0.98 ± 0.16 | 0.013 [c] |
| Without | 1.29 ± 3.88 | 1.06 ± 0.56 | 0.485 |
| **Stone size (mm)** | | | 0.333 |
| With | 34.61 ± 14.64 | 31.2 ± 15.96 | 0.105 |
| Without | 33.07 ± 13.24 | 32.97 ± 13.86 | 0.722 |
| **Duration of the operation (min)** | | | 0.718 |
| With | 47.09 ± 16.67 | 48.91 ± 16.69 | 0.476 |
| Without | 44.86 ± 19.08 | 45.71 ± 18.22 | 0.619 |
| **Total hospitalization (days)** | | | 0.000 [c] |
| With | 4.92 ± 2 | 2.88 ± 1.79 | 0.000 [c] |
| Without | 3.67 ± 1.51 | 2.17 ± 1.51 | 0.000 [c] |
| **Hospitalization after operation (days)** | | | 0.000 [c] |
| With | 3.66 ± 1.64 | 2.23 ± 1.19 | 0.000 [c] |
| Without | 2.52 ± 1.03 | 1.68 ± 0.9 | 0.000 [c] |

[a] Values are expressed as mean ± SD.

[b] Independent sample *t*-test.

[c] P-value ≤ 0.05.

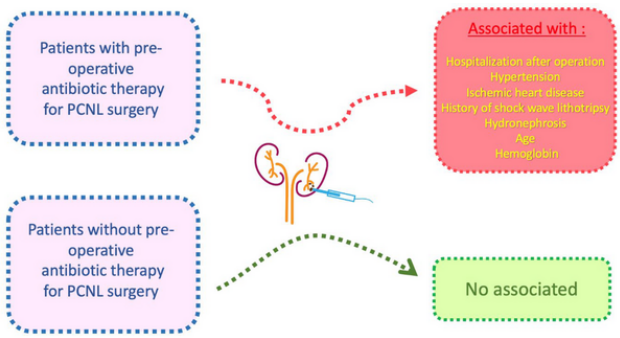


**Figure 1.** There is a significant relationship between total hospitalization, hospitalization after operation, hypertension, ischemic heart disease, history of shock wave lithotripsy, hydronephrosis, age, and hemoglobin with pre-operative antibiotic therapy for percutaneous nephrolithotomy (PCNL) surgery.

including those receiving glucocorticoids, cancer chemotherapy, and post-transplant immunosuppression. Also, patients who were older, cachectic, frail, or had chronic renal failure may have had a blunted fever response to infection. However, we do not assume that fever is always due to infection. In

fact, for many conditions of patients, the presence of fever may be variable.

The major hypothesis of this study was whether antibiotic therapy could reduce complications such as postoperative fever and sepsis in patients who underwent PCNL. The emergence of infection in our populations is serious. It could lead to increased complications, higher treatment costs, and longer hospital stays for patients. It is suggested that in the future, the difficulties of post-operative PCNL in patients who had received antibiotic therapy be investigated and compared in a randomized, double-blind clinical trial.

### *5.1. Conclusions*

We firmly believe that indiscriminate antibiotic prescription by surgeons could trigger the emergence of antibiotic-resistant bacteria. The rise of new generations of antibiotic-resistant bacteria in our populations is severe and could lead to increased complications, higher treatment costs, and longer hospital stays for patients. Realistically, antibiotic therapy and prophylaxis cannot prevent post-operative complications in some patients. The surgeon's experience, the emergence of antibiotic-resistant bacteria, and indiscriminate antibiotic prescription before PCNL can explain our findings.

## Acknowledgements

We would like to thank Guilan University of Medical Sciences for its assistance and guidance in this research.

## Footnotes

**Authors' Contribution:** Conceptualization, S.F, A.J; data curation, A.J, S.F; formal analysis, A.J, A.B, S.F; funding acquisition, A.J, S.F; investigation, A.J; methodology, A.J, S.F, M.B.S; project administration, A.J, S.F; software, A.J, S.F; validation, S.F; visualization, A.J, A.B; writing–original draft, A.J, S.F, A.B; writing–review & editing, A.J, S.F, A.B. All authors read and approved the final manuscript.

**Conflict of Interests Statement:** The authors declare that they have no competing interests.

**Data Availability:** The dataset presented in the study is available on request from the corresponding author during submission or after publication. This approach ensures data reproducibility while maintaining necessary confidentiality and compliance with ethical guidelines.

**Ethical Approval:** This study was conducted according to the guidelines laid down in the Declaration of Helsinki, and all procedures involving human participants were approved by the Ethics Committee of Guilan University of Medical Sciences (IR.GUMS.REC.1399.081 ).

**Funding/Support:** The authors received no specific funding for this work.

**Informed Consent:** Informed consent was obtained from all participants. We excluded participants under 16 years old from the study. All personal information of the patients remained confidential. And also, the principles of trusteeship were fully respected by the researchers.

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**Table 1.** General Information of Patients Before Operation (n = 708) [a]

| Variables | Antibiotic Therapy | |
|---|---|---|
| | Yes (n = 454/ Group 1) | No (n = 254/ Group 2) |
| **Sex; male / female** | 241/213 (53.1/46.9) | 138/116 (54.3/45.7) |
| **Age** | 49.11 ± 12.51 | 51.65 ± 12.23 |
| **Weight (g)** | 76.10 ± 14.61 | 77.67 ± 13.15 |
| **Body Mass Index (BMI)** | 27.73 ± 4.94 | 28.33 ± 4.65 |
| **BMI group** | | |
| Under weight | 12 (2.8) | 7 (2.9) |
| Normal | 120 (28.3) | 57 (23.3) |
| Over weight | 174 (41) | 111 (45.3) |
| Obese | 118 (27.8) | 70 (28.6) |
| **Hemoglobin. (g/dL)** | | |
| Preoperative | 13.08 ± 1.74 | 13.84 ± 8.17 |
| Postoperative | 11.55 ± 1.8 | 12.37 ± 1.82 |
| **Creatinine (mg/dL)** | | |
| Preoperative | 1.23 ± 2.23 | 1.1 ± 0.55 |
| Postoperative | 1.25 ± 3.31 | 1.05 ± 0.53 |
| **Glomerular filtration rate (min)** | | |
| Preoperative | 81.35 ± 30.38 | 113.99 ± 38.51 |
| Postoperative | 83.8 ± 26.56 | 86.57 ± 27.63 |
| **History of stone surgery** | 220 (48.8) | 127 (50.4) |
| **Number of stones** | 1.69 ± 0.46 | 1.74 ± 0.44 |
| **Urine culture before operative** | | |
| Positive | 78 (17.3) | 32 (18.5) |
| Negative | 376 (82.7) | 222 (81.5) |
| **Stone size (mm)** | 33.51 ± 13.69 | 32.77 ± 14.08 |
| **Location of stones** | | |
| Upper calyx | 26 (5.8) | 17 (7) |
| Middle calyx | 17 (3.8) | 10 (4.1) |
| Lower calyx | 60 (13.4) | 31 (12.7) |
| Pelvis | 66 (14.8) | 40 (16.4) |
| Staghorn | 19 (4.3) | 16 (6.6) |
| **Staghorn stone** | 39 (9.4) | 26 (10.8) |
| **Type of staghorn** | | |
| Complete | 12 (20.3) | 8 (25) |
| partial | 20 (33.9) | 13 (40.6) |
| **Surgery time (min)** | 45.48 ± 18.44 | 46.15 ± 18.01 |
| **Total hospitalization (days)** | 4.00 ± 1.75 | 2.26 ± 1.56 |
| **Hospitalization after operation (days)** | 2.83 ± 1.33 | 1.75 ± 0.96 |
| **Outcome** | | |
| Stone-free | 390(87.2) | 227(90.4) |
| Residual fragment < 4 mm | 23 (5.1) | 9 (3.6) |
| Residual fragment > 4 mm | 34 (7.6) | 15 (6) |
| **Underline disease** | | |
| DM | 77 (18) | 47 (18.7) |
| HTN | 147 (32.4) | 84 (33.5) |
| IHD | 23 (5.4) | 21 (8.4) |
| History of ESWL | 178 (39.2) | 100 (39.4) |
| **Complication** | | |
| Fever | 39 (11.2) | 10(4.8) |
| Extravasation | 1 (0.3) | 0 (0) |

| Variables | Antibiotic Therapy | |
|---|---|---|
| | Yes (n = 454/ Group 1) | No (n = 254/ Group 2) |
| Transfusion | 41 (11.8) | 8 (3.9) |
| Sepsis | 1 (0.3) | 0 (0) |
| Gross hematuria(prolonged) | 2 (0.6) | 0 (0) |
| Total | 123 (27.2) | 32 (12.6) |
| **Degree of hydronephrosis** | | |
| Sever | 55 (17.9) | 25 (16.3) |
| Moderate | 114 (37.1) | 67 (43.8) |
| Mild | 128 (41.7) | 52 (34) |

Abbreviations: DM, diabetes mellitus; HTN, hypertension; IHD, ischemic heart disease; URS, ureterorenoscopy; ESWL, extra-corporeal lithotripsy.

[a]Values are expressed as No. (%) or mean ± SD.

**Table 3.** Complication of Qualitative Variables Post-operative Percutaneous Nephrolithotomy (PCNL) in Patients with/Without Antibiotic Therapy [a]

| Variables | Antibiotic Therapy | | P-Value [b] |
|---|---|---|---|
| **Yes (n = 454/ Group 1)** | **No (n = 254/ Group 2)** | | |
| **Sex** | | | 0.814 |
| Male | | | 0.001 [c] |
| With | 60 (25) | 14 (10.2) | |
| Without | 180 (75) | 123 (89.8) | |
| Female | | | 0.007 [c] |
| With | 63 (29.7) | 18 (15.7) | |
| Without | 149 (70.3) | 97 (84.3) | |
| **BMI group** | | | 0.533 |
| Under weight | | | 0.147 |
| With | 7 (58.3) | 1 (14.3) | |
| Without | 5 (41.7) | 6 (85.7) | |
| Normal | | | 0.04 [c] |
| With | 32 (26.7) | 7 (12.3) | |
| Without | 88 (73.3) | 50 (87.7) | |
| Over weight | | | 0.034 [c] |
| With | 46 (26.6) | 17 (15.5) | |
| Without | 127 (73.4) | 93 (84.5) | |
| Obese | | | 0.002 [c] |
| With | 32 (27.4) | 6 (8.6) | |
| Without | 85 (72.6) | 64 (91.4) | |
| **Outcome** | | | 0.478 |
| Stone-free | | | 0.000 [c] |
| With | 95 (24.4) | 28 (12.4) | |
| Without | 294 (75.6) | 198 (87.6) | |
| Residual fragment < 4 mm | | | 0.101 |
| With | 11 (50) | 1 (11.1) | |
| Without | 11 (50) | 8 (88.9) | |
| Residual fragment > 4 mm | | | 0.015 [c] |
| With | 17 (50) | 2 (13.3) | |
| Without | 17 (50) | 13 (86.7) | |
| **Underline disease** | | | |
| DM | | | 0.054 |
| With | 23 (30.3) | 7 (14. 9) | |
| Without | 53 (69.7) | 40 (85.1) | |
| HTN | | | 0.009 [c] |
| With | 39 (26.7) | 10 (12) | |
| Without | 107 (73.3) | 73 (88) | |
| IHD | | | 0.050 [c] |
| With | 7 (30.4) | 1 (5) | |
| Without | 16 (69. 6) | 19 (95) | |
| **History of ESWL** | | | 0.003 [c] |
| With | 51 (28.8) | 13 (13) | |
| Without | 126 (71. 2) | 87 (87) | |
| **Hydronephrosis** | | | 0.000 [c] |
| Sever | | | 0.745 |
| With | 10 (18.2) | 3 (12) | |
| Without | 45 (81.8) | 22 (88) | |

| Variables | Antibiotic Therapy | | P-Value [b] |
|---|---|---|---|
| Moderate | | | 0.000 [c] |
| With | 34 (30.1) | 5 (7.6) | |
| Without | 79 (69.9) | 61 (92.4) | |
| Mild | | | 0.054 |
| With | 31 (24.4) | 6 (11.5) | |
| Without | 96 (75.6) | 46 (88.5) | |
| Total | | | 0.000 [c] |
| With | 78 (26.2) | 15 (10.5) | |
| Without | 220 (73.8) | 128 (89.5) | |

Abbreviations: BMI, Body Mass Index; JJ, double J ureteric catheter; C/S, culture and sensitivity test; DM, diabetes mellitus.

[a] Values are expressed as No (%).

[b] Chi-square or Fisher exact test.

[c] P-value ≤ 0.05.