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# Intraoperative Antibiotic Irrigation in Preventing Post-Ureterorenoscopy Urinary Tract Infection

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## ABSTRACT

**Background:** Postoperative urinary tract infection (UTI) remains a significant complication following ureterorenoscopy for stone management, which contributes to patient morbidity. Despite the use of antibiotic prophylaxis in routine, infection rates still persist, warranting investigation into adjunctive intraoperative strategies. **Objective:** To determine the efficacy of intraoperative antibiotic irrigation in preventing post-ureterorenoscopy urinary tract infection in patients with ureteral stones. **Study Design:** Quasi-experimental study. **Settings:** Urology Department, Peshawar Medical College and Allied Hospitals, Peshawar Pakistan. **Duration:** June 6th to 31st December 2025. **Methods:** One hundred patients undergoing ureterorenoscopy for ureteral stones were included. Of 100 patients, 75 received irrigation with normal saline containing gentamicin (80mg in 3 L), while 25 received normal saline irrigation only. Efficacy was assessed after 15 days of the procedure; no signs of clinically or microbiologically confirmed UTI were observed. Data was analysed with SPSS 23. **Results:** Mean age of the patients was 39.13±11.43 years. The mean operative time was 58.06±8.18 minutes, and the mean stone size was 8.41±1.33 mm. Efficacy was achieved in 64 (85.3%) patients in the antibiotic irrigation cohort, while 8 (32.0%) patients achieved efficacy in the normal saline cohort. This difference was statistically significant ($p < 0.001$). Common isolated pathogens were *Pseudomonas aeruginosa*, *Escherichia coli*, and *Klebsiella* species. **Conclusion:** Intraoperative antibiotic irrigation during URS reduces the risk of postoperative UTI in patients with ureteral stones. Antibiotic irrigation can be effective in reducing UTIs.

***Keywords:*** *Ureterorenoscopy, Antibiotic Irrigation, Urinary Tract Infection, Postoperative Complication, Gentamicin.*

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## INTRODUCTION

Ureterorenoscopy (URS) is the basis of treatment for upper urinary tract pathology, predominantly urolithiasis. In recent years, the adoption of this technique has been global and driven by significant technological refinements and enhanced energy sources, which have mutually increased procedural success while reducing morbidity. URS is a minimally invasive procedure and is considered a highly effective modality that permits direct visualization and management of intraluminal pathology. Still, postoperative infectious complications remain a clinical concern that can unfavourably influence the patient outcomes and healthcare costs.[1-3]

Modern Ho:YAG lasers offer precise, high-energy delivery, facilitating well-organized fragmentation of stone compositions while maintaining a good safety profile. Urological lasers have established utility for the treatment of urothelial tumours through vaporization and ablation, expanding the therapeutic scope of URS beyond stone disease.[4] Such innovations lead to minimum surgical times and higher stone-free rates. Prior to URS, patients typically undergo a comprehensive preoperative assessment, and routine evaluation includes a midstream urine culture to identify occult bacteriuria. High-risk groups include diabetes, immunosuppression, urinary tract anatomical irregularities, and a history of indwelling devices.[5-7] Management of this type of risk factor is indispensable for mitigating infection after the URS. Pre-operative antibiotics have been recognized as a vital pre-emptive approach. The American Urological Association (AUA) recommendations emphasize the administration of a single prophylactic antibiotic dose targeting uropathogens in patients undergoing URS.[8,9]

In recent years, intraoperative antibiotic irrigation has gained attention as an adjunctive measure to further reduce postoperative infectious complications. Such findings are particularly relevant in areas with higher antimicrobial resistance rates, where traditional prophylactic regimens appear less effective. A study conducted in Pakistan found the need for context-specific preventive approaches, as standard

international protocols may not fully address local epidemiological challenges.[10-12]

The rationale for this study is the ongoing risk of UTI following URS despite adherence to conventional preoperative antibiotic prophylaxis practices. Intraoperative antibiotic irrigation provides a targeted approach by swiftly minimizing the intraluminal bacterial load in the collecting system during maximal exposure time. Though evidence concerning its routine efficacy remains limited and inconsistent, particularly in regions with extraordinary antimicrobial resistance. Assessing the effectiveness of intraoperative antibiotic irrigation in preventing post-URS UTI is therefore essential for the determination of its potential role as a safe as well as cost-effective adjunct to standard prophylaxis and to guide the future clinical practice protocols.

## METHODS

This quasi-experimental study was conducted in the Urology Department, Peshawar Medical College and Allied Hospitals, Peshawar. Ethical approval was obtained from the IRB (Prime/IRB/2025/1163 on dated 5th of June 2025). Patients were selected using consecutive non-probability sampling. The sample size was calculated using the WHO Sample Size Calculator for comparing two proportions. The calculation was based on the efficacy rates reported in the reference study by Unno et al., in which the proportion of patients without postoperative urinary tract infection was 85.3% in the antibiotic irrigation group and 32.0% in the normal saline group.[10] Using a 95% confidence level, 80% power, and a ratio of 3:1 between the intervention and control groups, the minimum required sample size was estimated to be 100 patients (75 in the antibiotic irrigation group and 25 in the normal saline group). Therefore, a total of 100 patients were enrolled to ensure adequate statistical power to detect a significant difference between the two groups.

One hundred (n=100) patients aged between 18 and 65 years, of either gender, diagnosed with ureteral stones were recruited through convenient sampling technique. Diagnosis was confirmed by computed tomography (CT) scan, which showed the following features: a hyperdense focus in the ureter, hydroureter, and hydronephrosis in patients with clinical symptoms such as acute flank pain (VAS >3), nausea, and vomiting. Urine was collected before surgery began and patients who had active UTIs were excluded. All participants, irrespective of group assignment, had the same antibiotic prophylaxis during the peri-operative period based on hospital guidelines.

Before surgery, all patients had urine analysis and urine culture tests. Patients who had an active urinary tract infection (UTI) at the time of surgery were not included in this study. All patients in the study had peri-operative antibiotic and all received peri-operative antibiotic in line with the institutional protocol.

A brief explanation regarding the study was given to the patients, and their consent was taken on the consent form. Data collection was done for demographic details, including age, body mass index, residence, gender, socioeconomic status, education level, and employment status, along with comorbidities. Socioeconomic status was classified based on patients' monthly income. All patients underwent ureterorenoscopy under general anesthesia, which was defined as a minimally invasive endoscopic procedure in which a rigid or flexible ureteroscope was inserted through the urethra and bladder into the ureter for the diagnosis of ureteral stones. For this study, semi-rigid ureteroscopy was used.

Patients were assigned to receive either antibiotic or normal saline irrigation based on the order of their presentation. This allocation method resulted in 75 patients receiving antibiotic irrigation and 25 receiving normal saline irrigation. A 3:1 allocation ratio was selected during sample size calculation to maximize clinical exposure to the intervention while maintaining an adequate control group for comparison and preserving the statistical power required to detect a significant difference between the groups. The antibiotic irrigation group received a solution prepared by dissolving 80mg of gentamicin in a 3-liter pouch of normal saline, achieving a concentration of 26.7 mg/L, while the control group received plain normal saline irrigation at room temperature. The choice of gentamicin was based on its broad-spectrum coverage against common uropathogens.

The main outcome of this study was efficacy, defined as the absence of a clinically and microbiologically confirmed urinary tract infection within 15 days after the procedure. Diagnosis of a urinary tract infection was done using dipstick and microscopy, observing positive leukocyte esterase, positive nitrates, pyuria >10 WBC per HPF, and a positive urine culture demonstrating a single bacterial species with a colony count of $\geq 10^5$ CFU/mL, along with clinical symptoms such as frequent urination, dysuria, and fever. All the assessments were conducted under the supervision of an experienced urologist.

SPSS 23 was used for data analysis. The mean and standard deviation were used for age, BMI, stone size, and operative time. Efficacy, irrigation type, and demographics were presented as frequencies and percentages. The chi-square test was used to assess the efficacy of irrigation types. A p-value $\leq 0.05$ was considered significant.

## RESULTS

The present study included 100 patients. The patients had a mean age of 39.13 ± 11.43 years. Their BMI was 21.97 ± 1.46 kg/m², and their mean monthly income was 67,440 ± 12,753.54. The study cohort had 61 (61.0%) male and 39 (39.0%) female patients (Table 1). Comorbid conditions are presented in Table 2.

Clinical parameters indicated that the most common diagnosis was a right ureteric stone, found in 59 (59.0%) patients. The stone location was most frequent in the distal ureter 49 (49.0%). The mean stone size was 8.07 ± 1.44 mm. The mean operative time was 58.06 ± 8.18 minutes (Table 3). Efficacy was achieved in 64 (85.3%) patients receiving antibiotic irrigation, while 8 (32.0%) patients in the normal saline group. This difference was statistically significant ($P < 0.001$) (Table 4). The most frequently isolated organism in patients with UTI was *Pseudomonas aeruginosa*, found in 11 (39.3%) cases. This was followed by *Escherichia coli* in 7 (25.0%) cases (Table 5).

**Table 1: Demographic profile of the patients**

| Demographics | Demographics | n | % |
|---|---|---|---|
| **Gender** | Male | 61 | 61.0% |
| **Gender** | Female | 39 | 39.0% |
| **Socioeconomic Status** | Low | 18 | 18.0% |
| **Socioeconomic Status** | Middle | 70 | 70.0% |
| **Socioeconomic Status** | High | 12 | 12.0% |
| **Residence** | Rural | 38 | 38.0% |
| **Residence** | Urban | 62 | 62.0% |
| **Employment Status** | Employed | 73 | 73.0% |
| **Employment Status** | Unemployed | 27 | 27.0% |
| **Education Status** | Literate | 85 | 85.0% |
| **Education Status** | Illiterate | 15 | 15.0% |

**Table 2: Comorbidities**

| Comorbidities | Comorbidities | n | % |
|---|---|---|---|
| - | Yes/No | Frequency | Percentage |
| **Hypertension** | Yes | 28 | 28.0% |
| **Hypertension** | No | 72 | 72.0% |
| **Diabetes** | Yes | 15 | 15.0% |
| **Diabetes** | No | 85 | 85.0% |

**Table 3: Clinical parameters**

| Clinical parameters | Clinical parameters | n | % |
|---|---|---|---|
| **Diagnosis** | Left Ureteric Stone | 39 | 39.0% |
| **Diagnosis** | Right Ureteric Stone | 59 | 59.0% |
| **Diagnosis** | Bilateral Ureteric Stone | 2 | 2.0% |
| **Stone Location** | Proximal Ureter | 20 | 20.0% |
| **Stone Location** | Mid Ureter | 31 | 31.0% |
| **Stone Location** | Distal Ureter | 49 | 49.0% |
| **Stone Location** | Renal Pelvis | 0 | 0.0% |
| **Mean** | Mean | Mean | SD |
| **Stone size (mm)** | Stone size (mm) | 8.07 | 1.44 |
| **Operative time (min)** | Operative time (min) | 58.06 | 8.188 |

**Table 4: Comparison of efficacy in irrigation type**

| | Irrigation Type | Irrigation Type | Irrigation Type | Irrigation Type | |
|---|---|---|---|---|---|
| **Efficacy** | Normal Saline | Normal Saline | Antibiotic (Gentamycin in 80 mg in 3L NS) | Antibiotic (Gentamycin in 80 mg in 3L NS) | **P value** |
| | n | % | n | % | |
| **Yes** | 8 | 32.0% | 64 | 85.3% | < 0.001 |
| **No** | 17 | 68.0% | 11 | 14.7% | < 0.001 |

**Table 5: Pathogens of UTI**

| Parameter | n = frequency | % = percentage |
|---|---|---|
| **Pathogens** | n | % |
| **Valid Pseudomonas aeruginosa** | 11 | 39.3% |
| **E. coli** | 7 | 25.0% |
| **Klebsiella spp.** | 6 | 21.4% |
| **Staphylococcus spp** | 4 | 14.3% |

## DISCUSSION

The present study was conducted to evaluate the efficacy of intraoperative antibiotic irrigation for the prevention of post-URS urinary tract infection. The mean age of patients was 39.13 ± 11.43 years, which aligns with the age of presentation for symptomatic stone disease.[13] Male predominance was observed in this study, which is consistent with the higher prevalence of urinary stones in males across various populations.[13,14] Comorbid conditions are known to influence both stone formation and infection risk, such as hypertension, present in 28.0% of patients, and diabetes mellitus in 15.0%. Kim et al. reported that diabetes was present in 23.7% of their cohort.[15]

In the present study, 75.0% patients received irrigation with gentamicin (80 mg in 3 liters of normal saline), while 25.0% received normal saline alone. This aligns with the methodological approach used by Yildiz et al., who also used an irrigation solution containing gentamicin at 26.7 mg/L during retrograde intrarenal surgery.16 Their study reported a statistically significant reduction in postoperative fever and systemic inflammatory response syndrome (SIRS) with antibiotic irrigation.[16] Another study by Aghamir et al. used ceftriaxone irrigation as an alternative to intravenous prophylaxis for transurethral lithotripsy and found it to be superior as IV antibiotics, preventing infectious and inflammatory complications.[17] These studies support the concept of local antibiotic delivery during endoscopic stone surgery.

In the current study efficacy was defined as no UTI 15 days after the procedure. Efficacy was obtained in 85.3% of the patients that received irrigation with gentamicin and 32.0% in patients that were irrigated with normal saline. The efficacy of this size of group was larger than the differences indicated in previous studies. The higher rate of UTIs found in the present control group (68.0%) than those reported previously (7.8% and 2.0%) might be due to differences in the factors mentioned above, such as patient demographics, microbial epidemiology, antimicrobial resistance, surgical factors, or UTI criteria for defining postoperative UTIs. Also, the study was performed in a tertiary care center in which patients might have more complicated stone disease and risk factors that make them more prone to developing infectious complications. Shaikh et al., in their study, reported that febrile UTI occurred in 25% of patients after URS; the majority of them had positive urine

cultures (44%).[18] The results of the present study strongly highlight the potential of antibiotic irrigation as a powerful tool for controlling UTI post URS.

The pathogens isolated were *Pseudomonas aeruginosa* (39.3%), *Escherichia coli* (25.0%), *Klebsiella* species (21.4%), and *Staphylococcus* species (14.3%). These figures are consistent with typical uropathogens and align with the microbiological profile reported by Kim et al., who also found *P. aeruginosa* was a predominant cause of UTI in their study.[15]

The novelty of the present study lies in these findings, which demonstrated a very high efficacy rate for the antibiotic irrigation protocol in preventing postoperative UTI. While previous studies have focused on antibiotic irrigation as a means to reduce systemic inflammation or as a non-inferior alternative to intravenous drugs, this study provides compelling evidence for its potential superiority over saline irrigation alone in preventing the endpoint of infection itself.[16,17] It contributes meaningfully to the existing knowledge by suggesting that direct intraoperative antibiotic irrigation during lithotripsy may address a critical vulnerability that systemic prophylaxis cannot fully mitigate. The literature emphasizes the importance of stone and renal pelvic cultures, which often contain bacteria undetected by preoperative bladder urine tests.[19,20] Intraoperative antibiotic irrigation may act directly on this reservoir at the time of stone fragmentation, when bacterial and endotoxin release is most likely to occur.

## CONCLUSION

To summarize, intraoperative gentamicin irrigation during URS led to a significantly reduced rate of postoperative UTI in comparison to normal saline irrigation. These results indicate that antibiotic irrigation could be beneficial as an adjunctive treatment to decrease post-URS infectious complications. However, it is recommended that larger, multicentre, randomized controlled trials be done before implementation is recommended for general use, given the one center study design and non-randomized patient allocation.

## LIMITATIONS

Some restrictions are to be noted. The study was a single center study, and findings may not be extrapolated to other centers with different patient populations, surgical procedures and local antibiotic resistance. Further, the patients were not randomized, but rather assigned in the order that they presented, which may have created selection bias. Systematic collection of information about postoperative ureteral stenting was not performed, so its possible effects on postoperative UTI could not be assessed. However, due to time constraints, follow-up was only for 15 days after the procedure, sufficient to detect early postoperative infections but possibly not delayed infections. More detailed variables related to stents and longer follow-up should be included in future multicentre randomized studies.

## SUGGESTIONS / RECOMMENDATIONS

Randomized controlled trials in the future should focus on multicenter studies with balanced group size and similar peri-operative management protocols. More detailed information on postoperative ureteral stenting, pre- and post-operative urine cultures and longer follow-up would be valuable to better assess some of the factors that affect the rates of infection after ureterorenoscopy.

## CONFLICT OF INTEREST / DISCLOSURE

The authors declare no conflicts of interest.

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