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Role of Pre-Operative Single Dose Versus Double Dose Antibiotic in Prevention of UTI in Patients Undergoing Ureteroscopy with Negative Urine Culture

Manisha Ramchand[1], Arif Ali[2*], Naresh Kumar Valecha[1], Ayesha Khan[2], Abdul Mujeeb[1], Hassan Siddiqui[1] and Farooque Ahmed[3]

[1]Department of Urological Surgery and Transplantation, Jinnah Postgraduate Medical Centre, Karachi, Pakistan
[2]Department of Urological Surgery and Transplantation, Jinnah Sindh Medical University, Karachi, Pakistan
[3]Department of Urology, New Mowasat Hospital, Salmiya, Kuwait

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***Corresponding Author:**
Arif Ali
Department of Urological Surgery and Transplantation, Jinnah Sindh Medical University, Karachi, Pakistan
doc.arifshaikh@gmail.com

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ABSTRACT

Ureteroscopy (URS) is a minimally invasive procedure for ureteral stones, strictures, and tumors. Though generally safe, it carries a risk of postoperative urinary tract infections (UTIs), particularly with instrumentation or residual fragments. The optimal prophylactic antibiotic strategy remains debated. **Objectives:** To compare single- versus double-dose intravenous Ceftriaxone for preventing post-URS UTIs in patients with sterile preoperative urine. **Methods:** A prospective cohort study was conducted from 12 June to 11 December 2025, including 86 patients aged 18–60 years undergoing URS for ureteric calculi (0.5–2.0cm) with negative urine cultures. Patients were allocated to two equal groups: Group A received a single 2g intravenous Ceftriaxone dose at anesthesia induction, and Group B received two doses, 24 hours preoperatively and at induction. Exclusion criteria included uncontrolled diabetes or hypertension, positive culture, and cephalosporin allergy. Data were collected by a standardized proforma. Postoperative UTI was defined clinically (fever >100°F, TLC >10×10^9/L, pulse >100/min) and confirmed by urine culture. Statistical analysis was performed using SPSS version 22.0; $p<0.05$ was considered significant. **Results:** Baseline characteristics (age, BMI, gender) were comparable between groups ($p>0.05$). UTIs occurred in 11 patients (12.8%), with no significant difference between Group A (16.3%) and Group B (13.9%) ($p=0.74$). Isolated organisms included E. coli, Enterococcus faecalis, Proteus mirabilis, and Enterobacter. No significant associations were found with stone location, URS side, stenting, or diabetes. **Conclusions:** Single- and double-dose Ceftriaxone equally prevent post-ureteroscopy UTIs in sterile urine patients. Single-dose is a cost-effective, stewardship-friendly option. Further trials needed.

INTRODUCTION

Ureteroscopy (URS) has evolved into a fundamental minimally invasive approach for diagnosing and treating upper urinary tract conditions, including ureteral and renal stones, strictures, and urothelial tumors. This evolution has been driven in part by advancements in holmium laser technology and the widespread availability of rigid, semi-rigid, and flexible ureteroscopes with enhanced maneuverability and visualization capabilities [1]. Ureteric colic, most often caused by ureteric or migratory kidney stones, remains a common cause for emergency urological consultations. Lower pole stones, which are found in around 35% of cases, have the lowest likelihood of passing on their own. These residual fragments can also be managed with flexible ureterorenoscopy with laser lithotripsy [2]. Clinical guidelines from the EAU and AUA recommend URS as first-line therapy for symptomatic ureteral stones in most patients, except in those with severe comorbidities or uncontrolled urinary tract infections [3]. However, URS can introduce bacteria into the urinary tract via surgical instruments or retained stone fragments, thereby increasing the risk of postoperative UTIs and urosepsis [4]. Postoperative UTIs and surgical site infections are among the most common complications and significantly impact patient morbidity. Currently,

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recommended prophylaxis for URS includes antibiotics like fluoroquinolones and trimethoprim-sulfamethoxazole (TMP-SMX) as first-line options. Alternative agents include aminoglycosides (with or without ampicillin), amoxicillin/clavulanate, and first- to third-generation cephalosporins [5]. However, due to the lack of consensus and validated data, there remains a need to evaluate the efficacy of perioperative antibiotic prophylaxis in URS [6]. Multiple RCTs have shown different and inconsistent results. For instance, one study proved a significant reduction in postoperative UTI after extended antibiotic prophylaxis instead of standard fluoroquinolone-based regimens, but several other studies did not prove any significant benefit of antibiotic prophylaxis, especially in the low-risk patient group [7, 8]. In addition, guidelines in different urological societies vary due to the scarcity of randomized controlled trials and differences in their recommendations on prescribing antibiotic regimens and duration of prophylaxis needed for URS [9, 10].

Despite these differences, several studies continue to advocate for a single preoperative antibiotic dose, with extra doses deemed unnecessary. Therefore, to address this conflict in the context of clinical practice in Pakistan, and considering the rising antibiotic resistance as well as the need for cost-effective strategies in resource-limited healthcare settings, this study was conducted. This study aimed to compare the effectiveness of single-dose versus double-dose antibiotic prophylaxis in preventing postoperative UTIs in patients undergoing URS with negative preoperative urine cultures in the local population.

METHODS

This prospective cohort study was performed to assess the effectiveness of single versus double-dose antibiotic prophylaxis in preventing postoperative urinary tract infections (UTIs) in patients undergoing URS. The study was carried out in the Department of Urological Surgery and Transplantation, Ward 19, Jinnah Postgraduate Medical Centre (JPMC), Karachi, from 12th June till 11th December, 2025. Ethical approval from the Institutional Review Board was also obtained with ref no: NO.F.2-81/2025-GENL/298/JPMC; dated 29th May, 2025. A total of 86 patients were enrolled as per the inclusion criteria. Patients were allocated sequentially into two equal groups of 43 using a blindfolded allocation process to ensure balanced group distribution. The sample size was calculated using PASS 2020 Power Analysis and Sample Size Software (NCSS, LLC, Kaysville, Utah, USA), which determined that a sample of 86 would provide 83.06%. The study was powered to detect a 5% difference in postoperative UTI incidence between the two groups, with a significance level set at 0.05 with a baseline postoperative UTI rate of 25% [11]. The inclusion criteria comprised male and female patients aged 18 to 60 years with controlled diabetes mellitus and hypertension, undergoing URS for ureteric calculi measuring between 0.5 and 2.0 cm in size, located in the upper, middle, or distal ureter. Only patients with a negative preoperative urine culture were included. Exclusion criteria were a positive urine culture, age below 18 or above 60 years, uncontrolled or severe diabetes or hypertension, known allergy to cephalosporin, or any other contraindication to the use of the study antibiotics. Written informed consent was taken, and then patients were divided into two groups based on the prophylactic antibiotic regimen. Group A consisted of patients who received a single dose of 2 grams of intravenous Ceftriaxone, which was administered at the time of anesthesia induction. Group B consisted of patients who received two doses of 2 grams of intravenous Ceftriaxone, of which one was administered 24 hours before the surgery and the second was given at the time of anesthesia induction. Data were obtained by filling out a proforma, which included demographic details, medical history, intraoperative and postoperative data, and outcomes. The primary endpoint was the rate of urinary tract infections following surgery, diagnosed clinically (TLC > 10.0 x 109/L, Temp: >100oF, Pulse rate > 100 beats per minute and confirmed through urine culture and sensitivity testing. The study was conducted in accordance with all ethical standards. Before being included in the study, written informed consent was obtained from all the patients. Patient confidentiality was strictly taken care of throughout the study, and all efforts were made to avoid misconduct and to protect participants' rights and welfare. SPSS version 22.0 was used for statistical analysis. The incidence of UTIs in the two groups was compared using the chi-square test. A p-value below 0.05 was considered statistically significant.

RESULTS

Participant characteristics were comparable between the single-dose and double-dose groups. Mean age and BMI showed no statistically significant differences (Age: 41.2 ± 8.45 vs. 41.9 ± 7.76 years, p=0.77; BMI: 25.9 ± 3.56 vs. 27.7 ± 3.38, p=0.06). Gender distribution was also comparable, minimizing potential confounding effects on study outcomes, with males representing approximately half of each group (53.5% vs. 55.8%, p=0.82), as shown in table 1.

Table 1: Demographic Characteristics of the Participants (n=86)

Variables	Group	n	Mean ± SD / %	p-value
Age	Group 1 (Single Dose)	43	41.2 ± 8.45	0.77
	Group 2 (Double Dose)	43	41.9 ± 7.76	
BMI	Group 1 (Single Dose)	43	25.9 ± 3.56	0.06
	Group 2 (Double Dose)	43	27.7 ± 3.38	
Gender	Group 1 (Single Dose)	Male: 23	53.5%	0.82

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		Female: 20	46.5%	
	Group 2 (Double Dose)	Male: 24	55.8%	
		Female: 19	44.2%	

A total of eleven patients developed postoperative UTIs, either clinically or based on positive urine cultures. Statistical analysis by applying the Chi-square test showed no significant variation in postoperative UTIs incidence between the groups (p=0.74), as shown in figure 1.

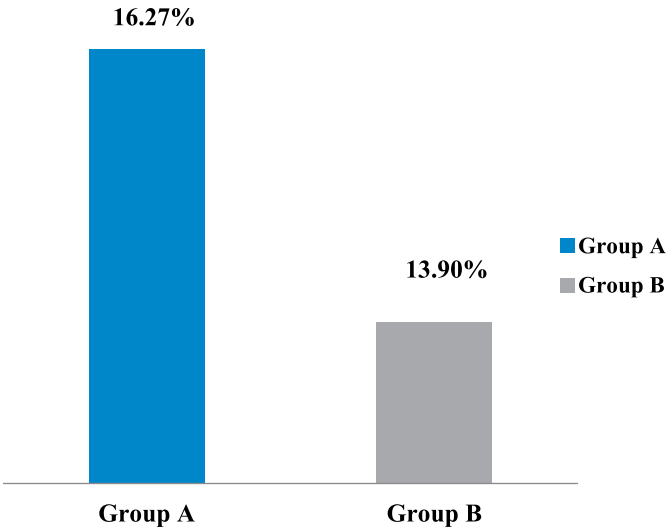

Figure 1: Frequency of Postoperative UTIs

In Group 1, seven patients (16.27%) experienced a UTI. One patient developed urosepsis, with urine culture revealing growth of *Enterobacter cloacae*. The remaining six cases reported symptoms typical of lower urinary tract issues consistent with cystitis; urine cultures identified *E. coli* in four patients, *Proteus mirabilis* in one, and one culture remained sterile, as shown in figure 2.

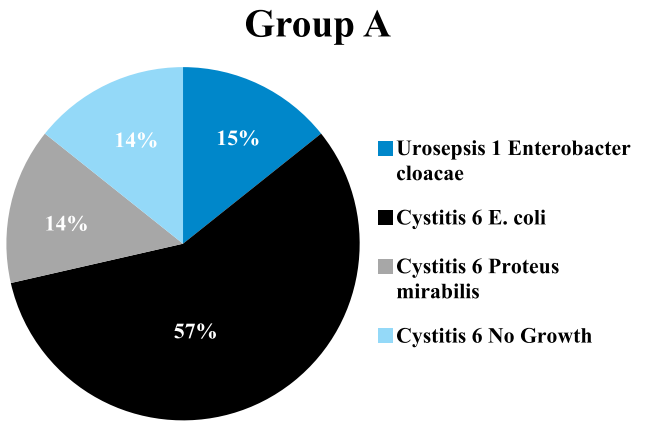

Figure 2: Number of Infected Cases and Organisms Involved in Group 1

Whereas in Group 2, six patients (13.9%) exhibited symptoms of postoperative UTIs. Pyelonephritis was diagnosed in two patients - one of them had a positive culture for *E. coli*, while the other had no growth. Four patients presented with cystitis; two cultures grew *E. coli*, one showed *Enterococcus faecalis*, and one was negative, as shown in figure 3.

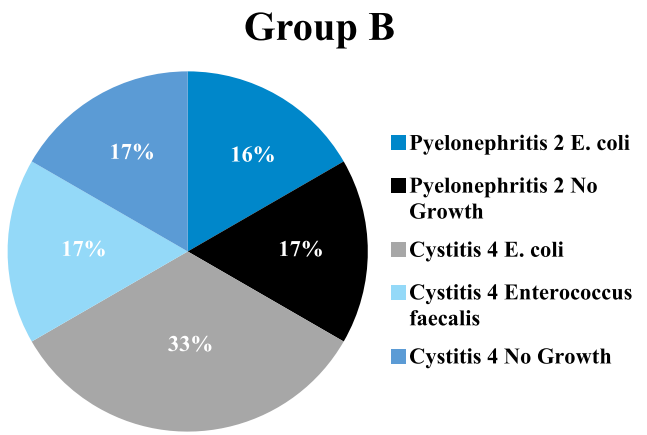

Figure 3: Number of Infected Cases and Organisms Involved in Group 2

All infections were managed successfully with appropriate antimicrobial therapy, and patients were discharged home in clinically stable condition post-therapy

A comparative analysis of surgical factors and infection risks between Group 1 and Group 2 is presented. There were no statistically significant differences between Group 1 and Group 2 regarding stone location, URS side, postoperative stent placement, or diabetes mellitus. Chi-square tests were used for comparisons involving stone location, URS side, and stent placement. Fisher's exact test was applied for diabetes mellitus due to the low frequency of positive cases, as shown in table 2.

Table 2: Comparison of Surgical Factors and Infection Risk Factors

Variables	Category	Group 1 (n=43)	Group 2 (n=43	p-value
Stone Location	Upper Ureter	9 (20.9%)	11 (25.6%)	0.33
	Mid Ureter	5 (11.6%)	9 (20.9%)	
	Lower Ureter	29 (67.4%)	23 (53.5%)	
URS Side	Right	22 (51.2%)	20 (46.5%)	0.67
	Left	21 (48.8%)	23 (53.5%)	
Postoperative Stent	Yes	34 (79.1%)	37 (86.0%)	0.39
	No	9 (20.9%)	6 (14.0%)	
Diabetes Mellitus	Yes	2 (4.7%)	1 (2.3%)	0.55
	No	41 (95.3%)	42 (97.7%)	

In summary, the results of this study suggest that single-dose and double-dose antibiotic prophylaxis regimens are equally effective in preventing postoperative UTIs following ureteroscopy stone management in patients with urine cultures taken pre-procedure showing no bacterial growth. The incidence of postoperative UTIs was low and statistically comparable among both groups, with no statistically significant variations observed in patient demographics, stone characteristics, or perioperative factors. These findings suggest that an antibiotic given as a single-dose regimen may be a sufficient and potentially more cost-effective approach for infection prevention in selected patients undergoing URS.

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DISCUSSION

To address ureteral stone diseases, ureteroscopy is commonly used, but like every procedure, it too carries the risk of postoperative UTIs. In the current cohort, 11 of 86 patients (12.8%) developed postoperative urinary tract infections, including cystitis, pyelonephritis, and even life-threatening urosepsis; this infection rate falls within the range reported in previous studies, which vary from approximately 2% to 33% depending on patient population, study design, and the use of ureteral stents. [12, 13]. As patients with specific risk factors were included in the current study, this explains the slightly increased infection rate in the current cohort. In the patient who had a post-procedural ureteral stent placed, 5 out of 71 (7.04%%) developed a postoperative UTI. This may be partially explained by microbial adherence and subsequent biofilm development on the stent external layer, a phenomenon observed in up to 25% of cases, depending on the stent dwell time [14]. However, despite bacterial presence, only around 10% of colonized stents lead to positive urine cultures [15], which is consistent with our findings as well. Multiple recent studies have demonstrated that prophylactic antibiotics do not prevent bacterial colonization of ureteral stents, indicating that antibiotics have limited utility in this context. [16-18]. Nonetheless, stent colonization does not consistently result in symptomatic infection, particularly in immunocompetent patients. The current study results indicated that 14 patients (16.3%) had preoperative ureteral stents, 9 in Group 1 (20.9%) and 5 in Group 2 (11.6%). Although this difference was not statistically significant (p=0.21), only one stented patient (8.5%) developed a postoperative UTI, suggesting that pre-stenting alone does not significantly increase infection risk in our cohort. These findings are in close agreement with the randomized controlled trial by Damavand *et al.* [19]. The current study found that preoperative ureteral stenting was not significantly associated with postoperative UTIs (8.5% infection rate in stented patients; p=0.21), suggesting that pre-stenting alone may not meaningfully elevate infection risk. This result aligns with Jennings *et al.* who compared single-dose preoperative antibiotics to combined pre- and postoperative dosing in URS: they observed postoperative UTI rates of 10% in the single-dose cohort versus 9.8% in the double-dose cohort (p=0.15), and reported that risk factors like preoperative stenting did not predict infection outcomes. Both studies together imply that a single preoperative antibiotic dose may be sufficient for stented patients and that extending antibiotics postoperatively has limited benefit [20]. Selection of an antibiotic for prophylaxis should be based on a variety of factors like agents' mechanism of action, site of action, tolerability, cost effectiveness, and low resistance. Among the antibiotics that are broadly prescribed are fluoroquinolones, aminoglycosides, and cephalosporins due to their broad-spectrum coverage, long serum half-lives, lower side-effect profiles, and cost-effectiveness. Particularly in the prevention of genitourinary infections, fluoroquinolones and cephalosporins provide comparable efficacy [21, 22].

In today's world, it is necessary to create a standardized antibiotic policy based on the local resistance profile. This not only addresses local resistance trends but also avoids unnecessary antibiotic use, thereby limiting rising resistance. The emergence of resistant organisms such as MRSA, *Pseudomonas aeruginosa*, and *Stenotrophomonas maltophilia* highlights the growing challenge. Hence, prophylactic antibiotic use should be restricted to clearly indicated scenarios to preserve antimicrobial efficacy for future use.

CONCLUSIONS

Single-dose antibiotic prophylaxis regimen appears to be as effective as double-dose prophylaxis in postoperative UTIs in patients undergoing ureteroscopy with negative preoperative urine cultures. The overall infection rate remained pretty low in each group, and no statistically significant differences were observed in the occurrence of infection, demographic profiles, or perioperative risk factors. These findings support the adoption of a single-dose prophylactic strategy as a safe and cost-effective option, especially in resource-limited healthcare settings.

Authors' Contribution

Conceptualization: MR
Methodology: MR, AA, NKV
Formal analysis: MR, AA, AK, HS
Writing and Drafting: MR, AA, NKV, AK, AM, HS
Review and Editing: MR, AA, NKV, AK, AM, HS, FA

All authors approved the final manuscript and take responsibility for the integrity of the work

Conflicts of Interest

All the authors declare no conflict of interest.

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