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REVIEW PAPER

UROLITHIASIS

Ureteral stents with extraction strings – a review on infection risk and prevention

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Introduction This review aims to determine whether the use of ureteral stents with extraction strings in adult patients undergoing upper urinary tract endoscopic procedures results in a higher incidence of urinary tract infections (UTIs) compared to stents without strings.

Material and methods A systematic literature search was conducted using PubMed, Scopus, and Google Scholar. Studies evaluating differences in UTI rates among adult patients with ureteral stents with or without extraction strings were included. Data on UTI rates, antibiotic prophylaxis protocols, and stent dwell time were extracted.

Results The review included 11 trials published between 2015 and 2023. One multicenter retrospective study involving 4,392 patients reported a significantly higher UTI rate in patients with extraction strings (2.1% vs 1.1%, p = 0.006). In the remaining 10 studies, including four randomized controlled trials, the differences were not statistically significant. Antibiotic prophylaxis was described in five studies. In two studies, a single perioperative antibiotic dose was administered, with a total UTI rate of 6.8% (28/410). In contrast, three studies using prolonged prophylactic antibiotic regimens reported a total UTI rate of 3.2% (13/403). The impact of stent dwell time on UTI risk could not be determined. The risk of bias was high in 10 studies and moderate in one retrospective study.

Conclusions Based on low-quality evidence, the difference in UTI risk between ureteral stents with and without extraction strings appears to be minimal and statistically insignificant. Well-designed studies with standardized methodologies are needed to clarify these findings.

Key Words: ureteral ‹› ureteric ‹› string ‹› stent ‹› tethered stent ‹› urinary tract infection ‹› prophylaxis ‹› ureteroscopy

INTRODUCTION

Preventing obstruction caused by oedema after upper urinary tract endoscopic procedures is one of the most common indications for ureteral stenting, and this usually requires only a few days of stenting. To reduce costs, invasiveness, and patient discomfort, stents with extraction strings are used in many centers [1–8]. Although this is an established procedure, we decided to review the available literature to assess the effect of a string protruding from the urethra on the risk of infection.

Furthermore, we observed a wide variation in antibiotic prophylaxis approaches in the published studies. Therefore, we considered it essential to evaluate the findings on stents with extraction strings in the context of antibiotic use.

Thus, the primary objective of this study was to determine whether the use of ureteral stents with extraction strings in adult patients after upper urinary tract endoscopic procedures resulted in a higher incidence of urinary tract infections compared to stents without strings (objective aligned with the PICO methodology). The secondary objective

was to assess whether the type of antibiotic prophylaxis used in these studies could have influenced the infection rates.

MATERIAL AND METHODS

Search strategy

A comprehensive literature search was performed in PubMed, Scopus, and Google Scholar/Google from database inception to January 15th, 2025. The systematic review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist and Cochrane guidelines. The search strategy involved identifying the terms "stent", "string", "tethered string", "ureteral", "ureteric", "ureteroscopy", and "retrograde" within titles, abstracts, key words, and Medical Subject Headings (MeSH). Additional studies were identified through manual searches of reference lists in relevant articles.

Eligibility criteria

We selected original research articles with available full texts, written in English. Our primary focus was on trials comparing infection rates between patients with ureteral stents with and without extraction strings, while also considering the use of antibiotic prophylaxis and dwell time. Articles not mentioning antibiotic prophylaxis were also included in the descriptive analysis. Studies that discussed the use of stents post-kidney transplant surgery were excluded. It was decided that only comparative studies with clearly described randomization and antibiotic prophylaxis would be used for final conclusions.

Study selection

The titles and abstracts of the selected studies were independently reviewed by two researchers based on the inclusion and exclusion criteria outlined below. Studies that did not meet the eligibility criteria were excluded, and any disagreements were resolved through discussion during a consensus meeting. The Rayyan® application was used to facilitate the systematic review process.

Data extraction

Data were extracted using a standardized form, including the following: study design, sample size, patient demographics., stent type (with string vs cystoscopic removal), UTI incidence and diagnostic criteria, antibiotic prophylaxis protocols, and stent dwell time.

Risk of bias assessment

The Cochrane Risk of Bias Tool was used for RCTs, and the ROBIN-I was applied to non-randomised case-control studies. Studies were categorised as low, moderate, or high risk of bias. The Robvis application was used to prepare risk-of-bias plots [9].

RESULTS

This review comprised 11 trials published between 2015 and 2023. Figure 1 presents the PRISMA flowchart illustrating the literature search process. Four trials were randomized controlled trials (RCTs) [10–13]. Among the non-randomized case-control studies, one had a prospective design [14], while six were retrospective [8, 15–19].

The risk of bias assessment for the RCTs, presented in Figure 2, indicated a high risk of bias across all included studies. The characteristics of these studies are detailed in Tables 1–3. None of the RCTs defined UTI incidence comparison between groups as the primary study objective. Instead, their primary focus was on patient discomfort or quality of life, with infection rates reported as a secondary outcome. No significant differences in UTI rates were observed among the RCTs, with a total of 14 reported UTI cases among 462 patients (3%). However, a substantial variation in UTI incidence was noted across studies, ranging from 0% to 9.1%.

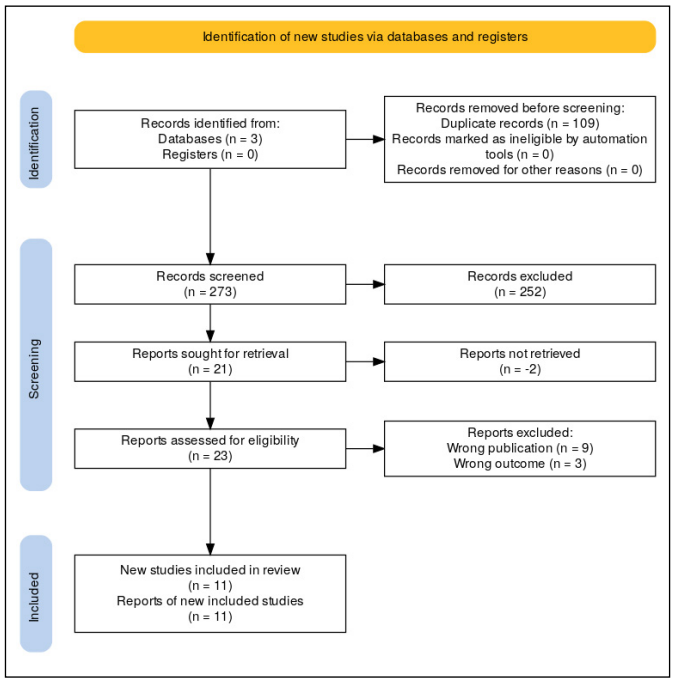

Figure 1. *Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram of the study.*

The duration of antibiotic prophylaxis was reported in three out of four studies [10, 12, 13], while the specific antibiotic used was mentioned in only one [13]. Notably, only the study by Barnes et al. [12] adhered to European Association of Urology (EAU) guidelines by implementing perioperative prophylaxis, while two studies reported extended administration beyond one day (Table 3).

The risk of bias assessment for the non-randomized studies is presented in Figure 3, with details summarized in Tables 1–3. Among these, one study was conducted prospectively, though its primary objective was to evaluate discomfort during stent removal rather than infection rates. Only two retrospective studies [15, 16] explicitly aimed to assess the impact of extraction strings on UTI risk. However, only one study [15] provided a well-defined outcome measure and a clearly described antibiotic prophylaxis regimen adhering to current guidelines. This study, conducted on a large patient cohort, found a higher incidence of UTI in patients with extraction strings, but the difference was not statistically significant (Table 1). The only study to report a significant difference was a large multicenter retrospective study including 4,392 patients [18], which found a 1% higher UTI incidence in the string group (2.1% vs 1.1%, p = 0.006). Overall, 8 out of 11 studies reported a higher UTI rate in the extraction string group compared to the non-string group, while two studies reported identical infection rates, and one study [8]

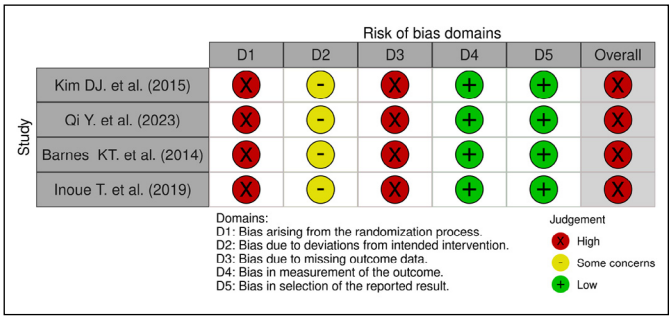

Figure 2. *Risk of bias in randomized controlled trials (ROB-2) [10–13].*

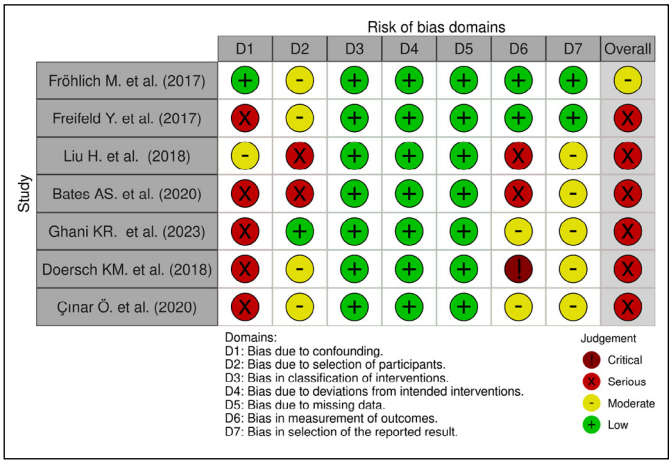

Figure 3. *Risk of bias in non-randomized controlled trials (ROBINS-I) [8, 14–19].*

Table 1. *Characteristics of the studies and reported urinary tract infection rates in stented patient groups without and with extraction strings*

Study	Research type	UTI as a primary or secondary objective of the study	Without extraction strings			With extraction strings			P for UTI	Information on antibiotic prophylaxis
			N	UTI	dwell time	N	UTI	dwell time		
Kim et al. (2015) [10]	RCT	Secondary	56	0	6.3 days	58	0	6 days	–	+
Qi et al. (2023) [11]	RCT	Secondary	66	1 (1.5%)	2.3 ±0.65 weeks	65	1 (1.5%)	2 ±0.3 weeks	0.99	–
Barnes et al. (2014) [12]	RCT	Secondary	35	3 (8.6%)	10.3 days	33	3 (9.1%)	6.3 days	0.94	+
Inoue et al. (2019) [13]	RCT	Secondary	75	2 (2.7%)	11.0 days	74	4 (5.4%)	9.7 days	0.4	+
Bates et al. (2020) [14]	Prospective	Secondary	30	2.8%	26.5 ±4.1 days	60	3.7%	10.1 ±5.3 days	>0.7	–
Fröhlich et al. (2017) [15]	Retrospective	Primary	215	12 (5.6%)	17.8 ±7.7 days	127	10 (7.9%)	7 ±2.4 days	0.4	+
Freifeld et al. (2017) [16]	Retrospective	Primary	133	4 (3%)	–	282	19 (6.7%)	–	0.12	–
Liu et al. (2018) [17]	Retrospective	Secondary	82	4 (4.9%)	11.2 ±3.2 days	58	3 (5.2%)	5.3 ±1.8 days	0.94	+
Ghani et al. (2023) [18]	Retrospective multicenter	Secondary	2,723	29 (1.1%)	9 (6.5–4) days	1,669	35 (2.1%)	5 (4–7) days	0.006	–
Doersch et al. (2018) [8]	Retrospective	Secondary	349	13 (3.7%)	–	94	2 (2.1%)	3 days	0.45	–
Çınar et al. (2020) [19]	Retrospective	Secondary	118	4 (3.4%)	12 days	59	3 (5%)	6 days	0.85	–

RCT – randomized clinical trial; UTI – urinary tract infection

found a higher UTI rate in the non-string group. Due to the substantial heterogeneity in study design, a meta-analysis could not be performed. In non-RCT studies antibiotic prophylaxis was mentioned in only two of seven studies [15, 17], and only in the Fröhlich et al. study [15] was it limited to the perioperative period, in accordance with guideline recommendations.

Overall, antibiotic prophylaxis protocols were described in five studies. In two studies, a single perioperative antibiotic dose was administered, with a total UTI rate of 6.8% (28/410). In contrast, three studies employing prolonged prophylactic antibiotic regimens reported a total UTI rate of 3.2% (13/403).

The impact of stent dwell time on UTI risk was specifically investigated in one study. Freifeld et al. [16] found that patients who had a stent with an extraction string and a dwell time exceeding 8 days had a significantly higher infection rate (20%) than those with a stent dwell time of 8 days or less (3.9%). Ghani et al. [18] also analysed effects of dwell time, however, their outcome of interest was emergency department visits rather than UTI incidence. The heterogeneity among studies precluded meaningful cross-study comparisons.

DISCUSSION

Our analysis does not provide a definitive answer regarding the impact of extraction strings on UTI incidence. However, several observations suggest a potential influence: most studies reported higher UTI rates in the extraction string group, the only study with a statistically significant difference [18] reported a higher infection rate for stents with strings, and the study with the lowest risk of bias [15] also found a numerically higher UTI incidence in the string group. Furthermore, both studies explicitly designed to compare UTI rates between groups reported higher infection rates in groups with extraction strings [15, 16]. Conversely, studies that found no difference in UTI incidence often reported exceptionally low infection rates (as low as 0%), raising concerns about the reliability of these findings.

These considerations do not constitute conclusive evidence, and the overall low quality of available studies concerning UTI incidence prevents firm conclusions about the impact of extraction strings on infection risk.

A second key aspect of this review was the evaluation of infection prevention strategies. Notably, extended antibiotic administration beyond a single perioperative dose was commonly employed in these studies. Antibiotic prophylaxis protocols were explicitly described in three RCTs and two non-RCTs. In the studies by Barnes et al. [12] and Fröhlich et al. [15], a single perioperative antibiotic dose was administered (presumably before ureteroscopy), whereas in three studies [10, 13, 17] prophylaxis was extended beyond one day.

Prolonged antibiotic administration contradicts current guidelines for ureteroscopy [20], as well as conclusions from previous research [21–25] which consistently show no significant benefit from extended antibiotic prophylaxis during stent dwell time. Studies have reported no difference between continuous

Table 2. *Definitions of urinary tract infection used in the studies included in the review*

Study	Urinary tract infection definitions
Kim et al. (2015) [10]	Febrile urinary tract infection requiring additional antibiotic treatment or a therapeutic procedure
Qi et al. (2023) [11]	Fever >38°C
Barnes et al. (2014) [12]	Symptomatic UTI
Inoue et al. (2019) [13]	Fever >38°C
Bates et al. (2020) [14]	–
Fröhlich et al. (2017) [15]	UTI within 30 days after stent placement. In patients without an extraction string UTI within 3 weeks after the procedure
Freifeld et al. (2017) [16]	Fever with a positive urinary culture or fever >38.5°C and no other infection source within 30 days after the procedure
Liu et al. (2018) [17]	Based on urinalysis within 1 month of stent placement or stent removal
Doersch et al. (2018) [8]	–
Ghani et al. (2023) [18]	Diagnosed at emergency department visit
Çınar et al. (2020) [19]	Urinary infection requiring antibiotic treatment

UTI – urinary tract infection

Table 3. *Information about antibiotic prophylaxis used in the studies. Only studies with a description of prophylaxis are listed*

Study	Description	Medication
Kim et al. [10]	Prophylactic antibiotics for several days after surgery	Not stated
Barnes et al. [12]	Perioperative prophylaxis	Not stated
Inoue et al. [13]	Antibiotic for 2 days after stent removal	Levofloxacin 500 mg/day
Fröhlich et al. [15]	Perioperative prophylaxis (half an hour prior to the procedure)	Trimethoprim/sulfamethoxazole (61.7%) Ciprofloxacin (32.2%) Other antibiotic (6.1%)
Liu et al. [17]	Prescription for prophylactic antibiotics at discharge	Not stated

low-dose antibiotic prophylaxis and a single preoperative dose. Continuous prophylaxis has been deemed unnecessary due to associated risks, including side effects and antimicrobial resistance. Although our review suggests a higher cumulative UTI rate in studies utilizing a single-dose antibiotic regimen compared to those using prolonged prophylaxis, the data originate from studies with a high risk of bias. The rationale for conducting further studies on this topic remains questionable. Analogous to findings on short-term indwelling Foley catheters, it is possible that extraction strings slightly increase infection risk (as suggested by Ghani et al. [18]), while prolonged antibiotic prophylaxis may slightly reduce this risk (as inferred from this review). However, even if this is the case, evidence from Foley catheter studies indicates that the minimal reduction in UTI risk does not justify prolonged antibiotic use due to its population-level harms, including increased antimicrobial resistance [26].

Further investigation is warranted into current clinical practices regarding antibiotic prophylaxis in patients undergoing endourological procedures with and without extraction strings. If significant variations exist, this topic should be discussed among experts in endourology and infectious diseases to promote guideline-adherent practices. The studies included in this review, which report on antibiotic prophylaxis, were conducted 6–11 years ago; therefore, an updated assessment of contemporary practices is needed.

CONCLUSIONS

Based on low-quality evidence, the difference in UTI risk between ureteral stents with and without extraction strings appears to be minimal and statistically insignificant. Variability in infection rates between studies was greater than within studies, which is probably due to heterogeneous antibiotic prophylaxis protocols and differing UTI definitions. Further investigation into current antibiotic prophylaxis practices in endourology is warranted, because variations in practice may serve as a target for future research. Future studies should incorporate well-defined outcome measures and clearly described prophylaxis protocols to provide more definitive conclusions.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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ETHICS APPROVAL STATEMENT

The ethical approval was not required.

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