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Predictive Factors of Failed Semi-Rigid and Flexible Ureteroscopy in the Treatment of Urinary Lithiasis

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Research Article

Keywords: Ureteroscopy, Urolithiasis, Tamsulosin, Ureteral stent, Endourology

Posted Date: July 15th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-10272173/v1

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Additional Declarations: No competing interests reported.

Abstract

Failed ureteroscopy (URS) at the first attempt of ureteroscope insertion is a major source of complications in the treatment of urolithiasis. This study aimed to determine the failure rate of flexible (f-URS) and semi-rigid ureteroscopy (s-URS) and to identify epidemiological or pharmacological factors that modify these outcomes.

In this retrospective observational study, 257 patients undergoing URS were included (129 s-URS and 128 f-URS). The overall failed-URS rate was 14.01%. Preoperative tamsulosin administered 7 days before the procedure decreased the failure rate from 18.95% to 6.73% ($p = 0.021$). Failure rates were 7.76% for s-URS and 20.31% for f-URS ($p = 0.006$). A trend toward higher failure was observed for stones in the proximal ureter, renal pelvis, and calyces ($p = 0.053$). In multivariable analysis, preoperative tamsulosin was independently associated with a lower risk of failed URS (OR 0.23, 95% CI 0.09–0.60; $p = 0.002$), whereas f-URS was associated with a higher risk (OR 4.37, 95% CI 1.88–10.15; $p = 0.001$).

Our failed-URS rate is comparable to previous series but derived from a larger cohort. Preoperative tamsulosin (particularly before f-URS) and the type of procedure were the only variables significantly associated with the failure rate, more than halving failed ureteroscopies. Stone location in the upper urinary tract showed a non-significant trend toward higher failure; prospective studies are required to confirm these findings.

Introduction

Ureteroscopy (URS) is an endourological procedure that allows the diagnosis and treatment of various pathologies of the upper urinary tract. Since the first dedicated ureteroscopes were developed in the late nineteenth and twentieth centuries—culminating in the longer instruments introduced by Pérez-Castro and Martínez-Piñeiro in 1980 that reached the renal pelvis [1]—and the first report of f-URS by Fuchs et al. in 1990, endourological procedures have progressively replaced open surgery and extracorporeal shock wave lithotripsy (ESWL) in the management of stone disease [2].

According to the European Association of Urology (EAU) Guidelines on Urolithiasis, endourological procedures (s-URS, f-URS, and percutaneous nephrolithotomy [PCNL]) and ESWL are first-line options for stones of 10–20 mm, whereas PCNL or f-URS is recommended for stones larger than 15 mm in the lower pole. Currently, f-URS has become the primary option for renal stones smaller than 20 mm because of its high stone-free rate (SFR) and low morbidity [3].

Although URS is considered optimal for treating urinary lithiasis in both adults and children, it is not free of complications, and failure during the first attempt of ureteroscope insertion is one of the primary risks [4]. Reported failed-URS rates range from 8.8% to 35% across series, which raises questions about the need for routine ureteral (double-J) stent placement [5, 6].

Some studies suggest that pre-procedural ureteral stenting (prestenting) improves procedural efficiency and the SFR [7, 8]. Others report no difference in SFR and higher rates of complications—urinary tract infection, perforation, urosepsis, ureteral avulsion, and bleeding—in prestented patients [5, 9, 10]. Whether a preoperative stent is required before s-URS or f-URS in patients without ureteral strictures therefore remains controversial [11]. Conversely, preoperative alpha-blockers such as tamsulosin and silodosin have been shown to reduce operative time and postoperative colic pain [2, 6]. The objective of this study was to determine the failure rate of f-URS and s-URS (defined as inability to endoscopically access the stone at the first attempt) and to establish whether specific epidemiological factors or drugs improve or worsen these outcomes.

Materials and methods

Study design and setting

This was a retrospective, observational, single-center study. It included male and female patients who underwent s-URS or f-URS for ureteral or renal lithiasis at the Hospital Privado Universitario de Córdoba between 1 March 2023 and 1 March 2025.

Inclusion and exclusion criteria

Inclusion criteria were: unilateral renal or ureteral lithiasis < 2.5 cm on computed tomography treated with s-URS or f-URS; negative urine culture, or an asymptomatic positive culture under targeted antibiotics; and, where applicable, tamsulosin 0.4 mg every 24 h for benign prostatic hyperplasia, medical expulsive therapy, or as a preoperative indication.

Exclusion criteria were: URS for non-lithiasis indications; need for emergency preoperative double-J stenting (febrile or symptomatic infection, creatinine > 3 mg/dL, or solitary-kidney lithiasis); and a pre-existing indwelling double-J stent.

Operative procedure

Patients under tamsulosin therapy received 0.4 mg every 24 h for 7 days. Procedures were performed by a staff urologist assisted by a urology resident (2nd–4th year). In general, s-URS was used for distal and mid-ureteral stones and f-URS for proximal ureteral, renal pelvic, or calyceal stones. A Storz 22-Fr cystoscope, a Richard Wolf 9-Fr semi-rigid ureterorenoscope, and an Innovex 8.7-Fr disposable flexible ureteroscope were used; no ureteral access sheath was used during f-URS. One or two hydrophilic safety guidewires were used in all cases. Pneumatic and Holmium-laser lithotripsy (Lumenis VersaPulse; 550-µm fiber for s-URS, 220-µm fiber for f-URS) were performed. When URS failed, a 6-Fr or 4.7/4.8-Fr × 26-cm double-J stent was placed and the procedure rescheduled at 15–20 days. Variable definitions and coding are provided in Online Resource 1.

Statistical analysis

Continuous variables are presented as mean (range) and categorical variables as counts (percentages). At univariable analysis, chi-square, Mann-Whitney U, and t-tests were applied as appropriate. Predictors of failed URS (dependent variable) were assessed by univariable and multivariable logistic regression; odds ratios (OR) with 95% confidence intervals (CI) and Wald p-values are reported, and overall model fit was evaluated with the likelihood-ratio test. Because f-URS and proximal stone location were strongly collinear (Spearman $\rho = 0.90$)—f-URS being selected specifically for proximal and intrarenal stones—these variables were not entered simultaneously, and stone position was reserved for sensitivity analyses. Two pre-specified models were built (one centered on tamsulosin and one on procedure type), each adjusted for age, sex, stone size, and stone multiplicity (~ 7 events per variable). Effect modification between tamsulosin and procedure type was tested with a multiplicative interaction term. A two-sided $p < 0.05$ was considered significant. Analyses were performed using R version 4.3 (R Foundation for Statistical Computing, Vienna, Austria).

Results

During the study period, 489 ureteroscopies were performed, of which 232 met at least one exclusion criterion, leaving 257 (52.55%) cases for analysis (129 s-URS and 128 f-URS). Demographic characteristics are shown in Table 1, and the analysis by variables in Table 2. The overall rate of inability to access the stone and proceed with lithotripsy (failed URS) was 14.01% (n = 36).

Table 1
Demographic characteristics of the patients (n = 257)

Demographic characteristics of the patients n = 257		
Sex	Men	144 (56.03%)
	Women	113 (43.97%)
Age (in years)		49.80 (18–91)
BMI		28.91 (20–52)
Smoking status	Yes	78 (30.35%)
	No	179 (69.65%)
Diabetes	Yes	34 (13.23%)
	No	223 (86.77%)
Hypertension	Yes	77 (29.96%)
	No	180 (70.04%)
Stone location	Renal pelvis and calyces	71 (27.63%)
	Proximal ureter	48 (18.67%)
	Mid-ureter	31 (12.07%)
	Distal ureter	107 (41.63%)
Stone size (in mm) *		9 (3–25)
Stone multiplicity	Single	199 (77.43%)
	Multiple (2 or more)	58 (22.57%)
Preoperative tamsulosin	Yes	104 (40.47%)
	No	153 (59.53%)
History of prior ureteroscopies	Yes	49 (19.07%)
	No	208 (80.93%)
History of prior ESWL	Yes	46 (17.90%)
	No	211 (82.10%)
History of prior retroperitoneal surgeries	Yes	39 (15.17%)
	No	218 (84.83%)
Type of Anesthesia	Regional	75 (29.18%)

Demographic characteristics of the patients n = 257		
	General	182 (70.82%)
Type of ureteroscope used	Semi-rigid	129 (50.19%)
	Flexible	128 (49.81%)

Values are presented as mean ± SD, median (range), or n (%). Bold p < 0.05.

Preoperative tamsulosin reduced the failed-URS rate from 18.95% to 6.73% (p = 0.021). By procedure type, the failure rate in s-URS was 8.70% without versus 7.23% with tamsulosin (p > 0.99), whereas in f-URS it was 23.59% without versus 4.77% with tamsulosin (p = 0.05 at univariable analysis). A trend toward higher failure was observed for more proximal stones (renal pelvis and calyces; p = 0.053), and f-URS carried a higher risk than s-URS (p = 0.006).

No significant association was found for sex (p = 0.81), age (p = 0.83), BMI (p = 0.59), smoking (p = 0.31), diabetes (p = 0.89), hypertension (p = 0.78), stone size (p = 0.95), stone multiplicity (p = 0.39), prior URS (p = 0.27), prior ESWL (p = 0.45), prior retroperitoneal surgery (p = 0.63), or type of anesthesia (p = 0.11).

Table 2
Correlation analysis of the evaluated variables

Results according to variables	Successful URS	Failed URS	p-value
Sex			0.81
Men	124 (86.11%)	20 (13.89%)	
Women	97 (85.84%)	16 (14.16%)	
Age (in years)	49 ± 18	50 ± 19	0.83
BMI	28.93 ± 5.3	28.77 ± 5.8	0.59
Smoking status			0.31
Yes	64 (82.05%)	14 (17.95%)	
No	157 (87.71%)	22 (12.29%)	
Diabetes			0.89
Yes	29 (85.29%)	5 (14.71%)	
No	192 (86.10%)	31 (13.90%)	
Hypertension			0.78
Yes	65 (84.42%)	12 (15.58%)	
No	156 (86.67%)	24 (13.33%)	
Stone Location			0.053
Distal ureter	96 (89.72%)	11 (10.28%)	
Mid-ureter	27 (87.10%)	4 (12.90%)	
Proximal ureter	40 (83.33%)	8 (16.67%)	
Renal pelvis and calyces	58 (81.69%)	13 (18.31%)	
Stone Size (in mm)	9.18 ± 5.11	9.22 ± 5.15	0.95
Stone Multiplicity			0.39
Single	173 (86.93%)	26 (13.07%)	
Multiple (2 or more)	48 (82.76%)	10 (17.24%)	
Preoperative Tamsulosin			0.021
Yes	97 (93.27%)	7 (6.73%)	
No	124 (81.05%)	29 (18.95%)	
History of prior URS			0.27

Results according to variables	Successful URS	Failed URS	p-value
Yes	44 (89.80%)	5 (10.20%)	
No	177 (85.10%)	31 (14.90%)	
History of prior ESWL			0.45
Yes	41 (89.13%)	5 (10.87%)	
No	180 (85.31%)	31 (14.69%)	
History of prior retroperitoneal surgeries			0.63
Yes	35 (89.74%)	4 (10.26%)	
No	186 (85.32%)	32 (14.68%)	
Anesthesia			0.11
Regional	69 (92.00%)	6 (8.00%)	
General	152 (83.52%)	30 (16.48%)	
Surgery Type			0.006
Semi-rigid URS	119 (92.24%)	10 (7.76%)	
Flexible URS	102 (79.69%)	26 (20.31%)	

Values are presented as mean ± SD, median (range), or n (%). Bold p < 0.05.

In multivariable analysis, after adjustment for age, sex, stone size, and multiplicity, preoperative tamsulosin was independently associated with a lower risk of failed URS (adjusted OR 0.23, 95% CI 0.09–0.60; p = 0.002), whereas f-URS was associated with a higher risk (adjusted OR 4.37, 95% CI 1.88–10.15; p = 0.001) (Fig. 1, Fig. 2). The protective effect of tamsulosin was concentrated in flexible procedures (failure 23.6% vs 4.8%) compared with semi-rigid procedures (8.5% vs 7.2%), although the tamsulosin-by-procedure interaction did not reach significance (p = 0.145).

Discussion

Since the introduction of PCNL by Fernström and Johansson in 1976 [12] and of f-URS by Fuchs et al. in 1990, endourological procedures have largely displaced open surgery and ESWL for stone disease [2]. Their widespread adoption raised the question of whether prestenting should be routine or selective. Early studies, such as those by Assimos et al. and Lumma et al., associated routine prestenting with fewer intraoperative or postoperative complications, at the expense of longer operative time [7, 13]. In contrast, Netsch et al. and Rubenstein et al. found no significant difference in complications between prestented and non-prestented patients [8, 14], and Hu et al. showed that routine prestenting significantly increases hospital costs [11].

Reported failed-URS rates at the first attempt without prestenting range from 8.8% (Zhang et al., f-URS, n = 114, alpha-blocker use unspecified) to 35% (Elmoazen et al., n = 20) [5, 6]. Our overall rate of 14.01% is consistent with these series and suggests that routine prestenting may not be necessary. Regarding preoperative medical management, Burak et al. reported that silodosin was modestly associated with easier ureteral-access-sheath placement and strongly associated with faster ureteral access [2]; Elmoazen et al. found a 10% failure rate with preoperative tamsulosin versus 35% with direct URS [6]; and the meta-analysis by Cheng et al. showed that tamsulosin improved ureteral navigation (OR 3.78; $p < 0.01$) [4].

In our cohort, failed URS occurred in 6.73% of the tamsulosin group versus 18.95% without it ($p = 0.021$). No significant association was found for sex, age, BMI, stone size, stone multiplicity, or anesthesia type, in line with prior literature [2, 5, 6]; smoking, diabetes, hypertension, and prior URS, ESWL, or retroperitoneal surgery were likewise non-significant. A non-significant trend toward higher failure was noted for proximal stones ($p = 0.053$).

After adjustment for age, sex, stone size, and multiplicity, tamsulosin remained independently protective (adjusted OR 0.23; $p = 0.002$) and f-URS a risk factor (adjusted OR 4.37; $p = 0.001$). The protective effect of tamsulosin was concentrated in flexible procedures (23.6% vs 4.8%) versus semi-rigid procedures (8.5% vs 7.2%). Notably, the protective association of tamsulosin attenuated when adjusting for procedure type or stone position; given the strong collinearity between f-URS and proximal location, we interpret this as over-adjustment (confounding by indication) rather than absence of effect. Thus, preoperative tamsulosin, procedure type, and stone location appear to be the main predictors of failed URS, although randomized prospective trials are required for confirmation.

This study has limitations: its retrospective, single-center design; minor variability in the surgical team; and the use of 8.7-Fr flexible ureteroscopes, as results might differ with smaller-caliber instruments. In addition, with only 36 events, multivariable models were kept parsimonious to avoid overfitting.

Conclusion

The failed-URS rate in our study is comparable to previously published series but derives from a larger Latin American cohort, adding evidence to prior reports. Preoperative tamsulosin (particularly before f-URS), together with the type of procedure, were the only variables significantly associated with the failure rate, more than halving failed ureteroscopies. Stone location in the upper urinary tract showed a non-significant trend toward higher failure; further prospective studies are needed to confirm these findings.

Declarations

Competing interests

The authors have no relevant financial or non-financial interests to disclose.

Ethics approval

This study was performed in line with the principles of the Declaration of Helsinki. Approval, including retrospective access to medical records, was granted by the Ethics Committee of the Hospital Privado Universitario de Córdoba (approval No. 03975).

Consent to participate

Given the retrospective design based on de-identified records, the Ethics Committee waived the requirement for individual informed consent.

Consent to publish

Not applicable; the manuscript contains no individually identifiable patient data.

Funding

No funding was received for the preparation of this manuscript.

Author Contribution

All authors contributed to the study conception and design. Data collection and analysis were performed by [Buffa, A], [Alvarez, J], [Sosa, A], [Colla, R], and [Metrebian, E]. The first draft was written by [Buffa, A], and all authors commented on previous versions. All authors read and approved the final manuscript.

Data availability

The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

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Figures

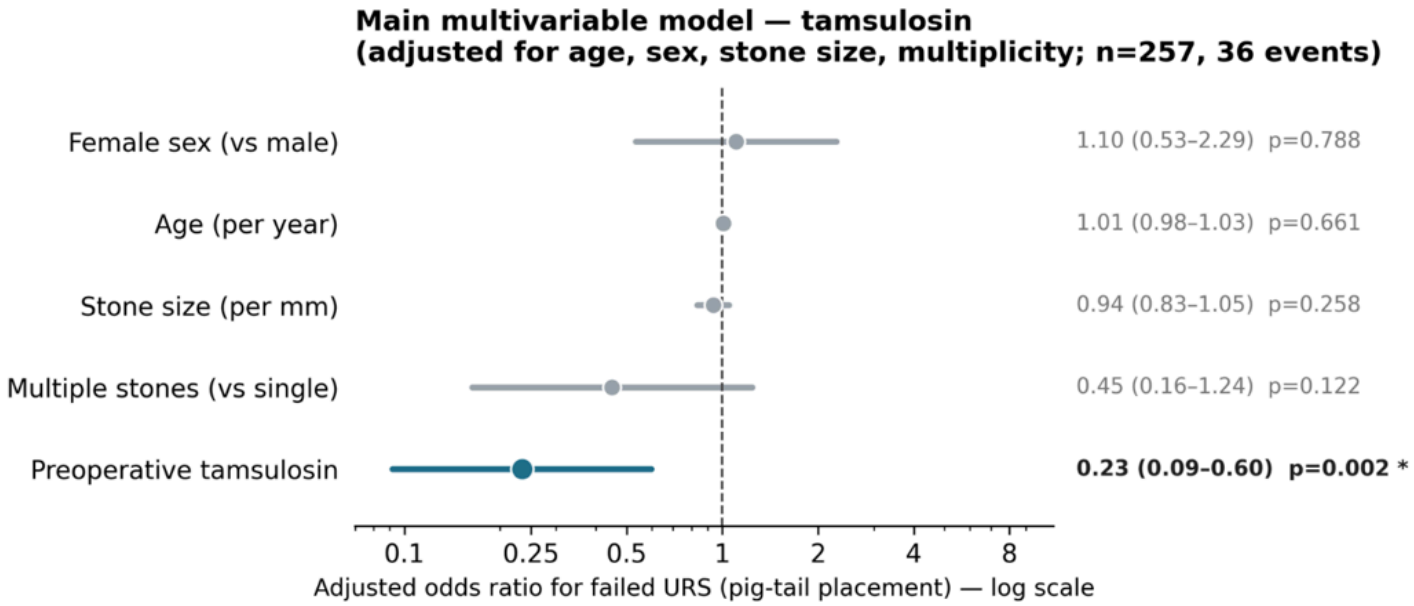


Figure 1

Multivariable logistic-regression model for preoperative tamsulosin, adjusted for age, sex, stone size, and stone multiplicity (OR<1 indicates a lower risk of failed ureteroscopy).

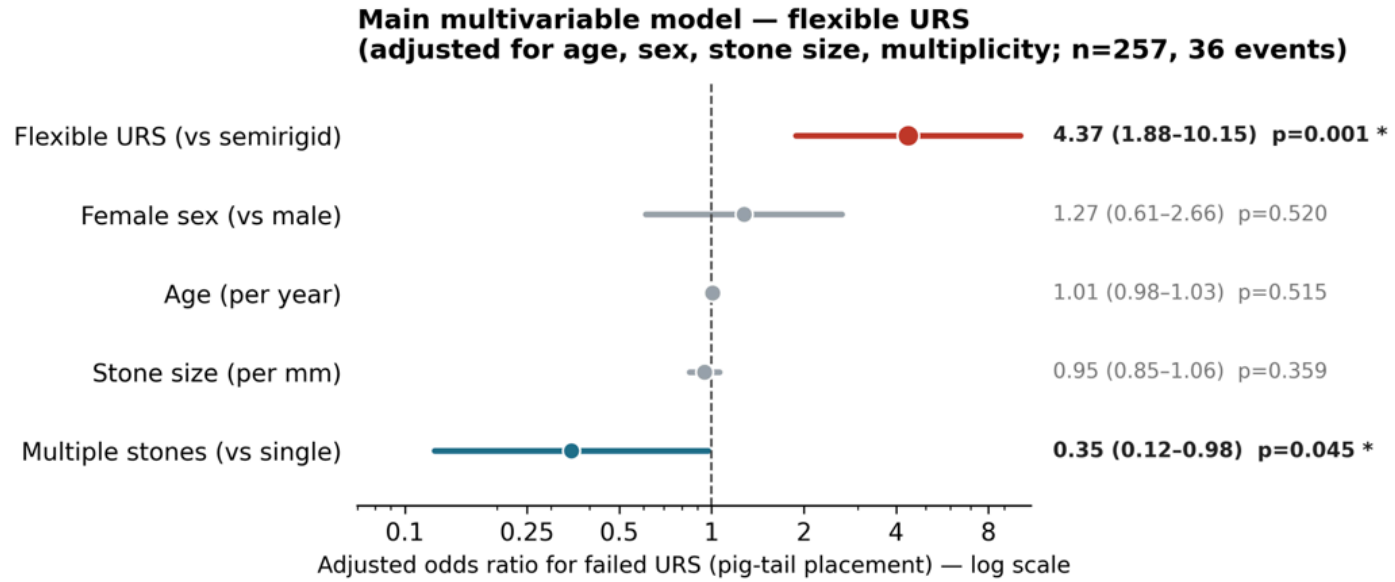


Figure 2

Multivariable logistic-regression model for flexible ureteroscopy versus semi-rigid ureteroscopy, adjusted for age, sex, stone size, and stone multiplicity (OR>1 indicates a higher risk of failed ureteroscopy)