Research Square

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The Impact of Preoperative Stent Placement and Stent Duration on Stone-Free Rate and Postoperative Fever

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Abstract

Background

To evaluate the impact of preoperative ureteral stenting (pre-stenting) and stent dwell time on operative outcomes, stone-free rate (SFR), and postoperative febrile urinary tract infection (fUTI) after transurethral lithotripsy (TUL).

Methods

We retrospectively analyzed 795 patients who underwent initial TUL for renal or ureteral stones between January 2023 and December 2024 at our institution and affiliated hospitals. Patients who underwent ureteral stenting for infectious indications were excluded. Outcomes included operative time, SFR, and postoperative fUTI. Inverse probability of treatment weighting (IPTW) was used to adjust for baseline differences between patients with and without pre-stenting. Subgroup analyses were performed according to stent dwell time (< 30 vs ≥ 30 days).

Results

Of the 795 patients, 229 underwent pre-stenting and 566 did not. After IPTW adjustment, pre-stenting was associated with shorter operative time ($p = 0.046$), whereas SFR and postoperative fUTI rates were comparable between groups. Multivariable analysis identified age, stone size, and CT attenuation value as independent predictors of SFR, whereas no independent predictors of postoperative fUTI were identified. In patients with pre-stenting, a dwell time ≥ 30 days was associated with trends toward lower SFR and higher postoperative fUTI rates, although these differences were not statistically significant.

Conclusions

Pre-stenting may shorten operative time but did not improve SFR or increase postoperative fUTI after adjustment for baseline differences. Routine pre-stenting may not be required without clear clinical indications, and prolonged stent dwell time should be avoided.

1. Introduction

Transurethral lithotripsy (TUL) has become a standard minimally invasive procedure for the management of upper urinary tract calculi [1]. Preoperative ureteral stenting (pre-stenting) is commonly used to achieve passive ureteral dilation and facilitate ureteroscope or access sheath placement. Several studies have suggested that pre-stenting shortens operative time and improves stone-free rate (SFR), particularly in patients with large renal stones or difficult upper tract access. However, the reported benefits remain inconsistent [2–4].

Pre-stenting is also associated with potential disadvantages, including stent-related discomfort, bacterial colonization, and postoperative infectious complications. Furthermore, prolonged stent dwell time may increase the risk of postoperative febrile urinary tract infection (fUTI), although available evidence remains conflicting [5–7]. Importantly, the independent effects of pre-stenting itself and stent dwell time are often not clearly distinguished, and their respective impact on operative outcomes, SFR, and postoperative infectious complications remains poorly defined [8–12].

Given these conflicting findings, we investigated the effects of preoperative stenting and stent dwell time on operative outcomes, SFR, and postoperative fUTI after TUL using inverse probability of treatment weighting (IPTW) to account for baseline differences between groups.

2. Materials and Methods

2.1. Patient selection

We retrospectively reviewed patients who underwent initial TUL for renal or ureteral calculi at our institution and affiliated hospitals between January 2023 and December 2024. A total of 795 patients were included in the analysis. Among them, 229 patients underwent pre-stenting, and 566 patients did not. Among patients who underwent pre-stenting, 114 patients had a stent dwell time of less than 30 days, and 115 had a duration of 30 days or more. (Fig. 1). Patients who required stent placement because of pain, worsening renal function, or surgeon preference were included; however, patients who underwent stent placement for infectious indications, such as obstructive pyelonephritis, were excluded. In all patients, first- and second-generation cephalosporins and penicillins combined with beta lactamase inhibitor were administered as intraoperative antibiotics in accordance with guidelines [13]. In cases where preoperative urine cultures were positive, antibiotics corresponding to the susceptibility results were administered preoperatively at the surgeon's discretion.

2.2 Treatment strategy, outcome measurement and definition

All procedures were performed under general anesthesia with the patient in the lithotomy position. A semirigid ureteroscope was used for lower ureteral stones, whereas a flexible ureteroscope was used for upper ureteral and renal stones. Several commercially available reusable and single-use flexible ureteroscopes were used across participating institutions. During flexible ureteroscopy, a ureteral access sheath (12–15 Fr selected by the surgeon's discretion) was placed under fluoroscopic guidance. Ureteral access sheaths from different manufacturers were used according to institutional availability and surgeon preference. Stone fragmentation was performed using a Holmium: Yttrium-aluminum-Garnet laser. Laser energy and pulse frequency settings were adjusted according to stone burden, stone density, and surgeon preference. At the end of the procedure, a 6 Fr double-J ureteral stent was placed.

SFR was defined as the absence of residual fragments > 4 mm on computed tomography(CT) within 1 month after surgery. Postoperative fUTI was defined as a body temperature ≥ 38.0°C within 48 h after

surgery accompanied by clinical signs of urinary tract infection and requiring antibiotic treatment.

2.3 Statistical Analysis

Continuous variables were compared using Student's t-test or the Mann–Whitney U test, as appropriate. Categorical variables were analyzed using the chi-square test or Fisher's exact test. Univariate and multivariate logistic regression analyses were performed to identify independent predictors of SFR and postoperative febrile events.

Because baseline characteristics differed between patients with and without pre-stenting, inverse probability of treatment weighting (IPTW) based on propensity scores was additionally performed to reduce selection bias. Propensity scores were calculated using age, sex, BMI, diabetes mellitus, stone size, stone multiplicity, stone location, CT attenuation value, and preoperative urine culture results. Covariate balance before and after IPTW was assessed using standardized mean differences (SMD), with values < 0.1 considered acceptable.

Subgroup analyses were conducted according to stent dwell-time cutoff (< 30 vs ≥ 30 days), which has been commonly adopted in previous reports and clinical practice [9, 10, 13].

3. Results

3.1 Patient characteristics and IPTW adjustment

Of the 795 patients, 229 (28.8%) underwent pre-stenting before TUL. Baseline characteristics are summarized in Table 1. Before adjustment, women were significantly more common in the pre-stenting group. To reduce potential selection bias, IPTW adjustment was performed. After weighting, all baseline covariates achieved adequate balance, with standardized mean differences below 0.1.

Table 1
Baseline characteristics before and after IPTW adjustment

Variable	Before IPTW Without pre-stenting N = 566	Before IPTW With pre-stenting N = 229	SMD	After IPTW Without pre-stenting Weighted N = 565.7	After IPTW With pre-stenting Weighted N = 229.9	SMD
Age, mean (SD), years	59.79 (13.81)	59.83 (13.95)	< 0.01	59.83 (13.79)	59.99 (13.86)	0.01
Sex, n (%)			0.08			< 0.01
Male	402 (71.0)	145 (63.3)		389.9 (68.9)	159.3 (69.3)	
Female	164 (29.0)	84 (36.7)		175.8 (31.1)	70.6 (30.7)	
BMI, mean (SD), kg/m²	24.40 (4.22)	24.44 (4.23)	0.01	24.42 (4.26)	24.43 (4.14)	< 0.01
History of diabetes mellitus, n (%)			0.03			< 0.01
No	484 (85.5)	188 (82.1)		477.8 (84.5)	193.8 (84.3)	
Yes	82 (14.5)	41 (17.9)		87.9 (15.5)	36.2 (15.7)	
Stone diameter, mean (SD), mm	10.84 (5.22)	10.38 (5.72)	0.08	10.73 (5.15)	10.97 (6.74)	0.04
Number of stones, n (%)			< 0.01			< 0.01
Single	473 (83.6)	193 (84.3)		473.7 (83.7)	192.6 (83.8)	
Multiple	93 (16.4)	36 (15.7)		92.0 (16.3)	37.3 (16.2)	
Stone location, n (%)			0.05			< 0.01
Ureter	397 (70.1)	149 (65.1)		388.7 (68.7)	157.7 (68.6)	
Kidney	169 (29.9)	80 (34.9)		177.0 (31.3)	72.3 (31.4)	
CT value, mean (SD), HU	799.66 (319.57)	780.53 (359.71)	0.06	795.04 (320.19)	798.58 (361.11)	0.01

Values after IPTW are weighted estimates and are presented as weighted mean (SD) or weighted n (%). SMD, standardized mean difference; IPTW, inverse probability of treatment weighting. An SMD < 0.1 was considered to indicate adequate covariate balance.

Variable	Before IPTW Without pre-stenting N = 566	Before IPTW With pre-stenting N = 229	SMD	After IPTW Without pre-stenting Weighted N = 565.7	After IPTW With pre-stenting Weighted N = 229.9	SMD
Preoperative urine culture, n (%)			0.05			< 0.01
Negative	394 (69.6)	147 (64.2)		385.4 (68.1)	157.3 (68.4)	
Positive	172 (30.4)	82 (35.8)		180.3 (31.9)	72.6 (31.6)	

Values after IPTW are weighted estimates and are presented as weighted mean (SD) or weighted n (%). SMD, standardized mean difference; IPTW, inverse probability of treatment weighting. An SMD < 0.1 was considered to indicate adequate covariate balance.

3.2 Operative outcomes and stone-free rate after IPTW adjustment

After IPTW adjustment, operative time remained significantly shorter in the pre-stenting group than in the non-stenting group (mean difference − 6.19 min, 95%CI -11.99 to -0.39, p = 0.036). In contrast, SFR and postoperative fUTI rates were comparable between groups. IPTW-adjusted SFR rates were 85.2% and 85.4% in the pre-stenting and non-stenting groups, respectively (p = 0.95), whereas postoperative fUTI rates were 5.0% and 6.4%, respectively (p = 0.46) (Table 2).

Table 2
IPTW-adjusted operative outcomes according to preoperative stenting

Variable	Without pre-stenting N = 566	With pre-stenting N = 229	p-value
Operation time, median (min-max), min	62.0 (9.0-260.0)	51.0 (7.0-200.0)	0.036
SFR			0.95
SF	483 (85.3%)	197 (86.0%)	
Non-SF	83 (14.7%)	32 (14.0%)	
Postoperative fever	36 (6.4%)	12 (5.2%)	0.46

3.3 Predictors of SFR and postoperative fUTI

Multivariable logistic regression analysis identified age (OR: 0.98, 95% CI 0.96-1.00), stone size (OR: 0.86, 95% CI 0.82–0.89), and CT attenuation value (OR: 1.00, 95% CI 1.00–1.00) as independent predictors of SFR (all p < 0.01), whereas pre-stenting was not independently associated with SFR (p = 0.87). No independent predictors of fUTI were identified (Table 3,4 and Fig. 2,3).

Table 3
Univariate and multivariable logistic regression analyses for predictors of stone-free status

Variable	Univariate OR	95% CI	p-value	Multivariate OR	95% CI	p-value
Sex	0.86	0.57–1.32	0.50	0.83	0.52–1.34	0.43
Age	0.98	0.96–0.99	0.006	0.98	0.96-1.00	0.023
BMI	1.00	0.95–1.04	0.84	0.97	0.92–1.02	0.24
Number of stones	0.48	0.31–0.78	0.002	0.87	0.51–1.54	0.63
Stone diameter	0.84	0.81–0.87	< 0.001	0.86	0.82–0.89	< 0.001
CT value	1.00	1.00–1.00	< 0.001	1.00	1.00–1.00	< 0.001
With pre-stenting	1.06	0.69–1.66	0.80	1.04	0.64–1.72	0.87

Table 4
Univariate and multivariable logistic regression analyses for predictors of postoperative febrile urinary tract infection

Variable	Univariate OR	95% CI	p-value	Multivariate OR	95% CI	p-value
Sex	1.48	0.80–2.68	0.20	1.37	0.71–2.56	0.34
Age	1.02	0.99–1.04	0.16	1.01	0.99–1.04	0.30
BMI	1.02	0.95–1.09	0.54	1.04	0.97–1.11	0.28
History of DM	1.10	0.47–2.29	0.81	0.96	0.40–2.05	0.92
Preoperative urine culture	1.88	1.03–3.38	0.036	1.70	0.91–3.14	0.09
Operation time	1.00	1.00-1.01	0.25	1.00	1.00-1.01	0.30
With pre-stenting	0.81	0.40–1.55	0.55	0.79	0.38–1.51	0.49

3.4 Subgroup analysis by stent dwell time

Subgroup analysis using a 30-day stent dwell time cutoff showed that patients with a dwell time ≥ 30 days had numerically lower SFR (88.2 vs 88.3%) and higher postoperative fUTI rates (6.7 vs 3.4%) compared with those with a dwell time > 30 days, although neither difference reached statistical significance (p = 0.22 and p = 0.26, respectively) (Supplementary Table 1).

4. Discussion

In this multicenter retrospective study of patients undergoing initial TUL, preoperative ureteral stenting was not associated with improved SFR or increased postoperative febrile events after adjustment for baseline differences using IPTW. In contrast, pre-stenting was associated with a shorter operative time. In the subgroup of patients with pre-stenting, a stent dwell time of ≥ 30 days showed trends toward lower SFR and higher postoperative fUTI rates, although these differences did not reach statistical significance. These findings suggest that pre-stenting may facilitate the procedure itself, but routine pre-stenting may not provide additional clinical benefit in terms of stone clearance or infectious outcomes in patients without clear indications.

The potential benefit of pre-stenting has been attributed to passive ureteral dilation, which may facilitate ureteroscope advancement, ureteral access sheath insertion, and stone retrieval [4, 11]. Although passive ureteral dilation may facilitate access sheath insertion and endoscope maneuverability, modern flexible ureteroscopes and laser technologies may have reduced the incremental benefit of routine pre-stenting. In the present study, IPTW-adjusted analysis showed that operative time was shorter in the pre-stenting group than in the non-stenting group, whereas SFR was almost identical between the groups. This supports the interpretation that pre-stenting may improve procedural efficiency but does not necessarily translate into better stone clearance.

This finding is consistent with previous reports. Chu et al. showed that pre-stenting reduced operative time and reoperative rates, particularly in patients with stone burden > 1 cm and stones located in the proximal ureter or kidney, while radiological clearance was not significantly improved [3]. In contrast, the CROES URS Global Study demonstrated that the effect of preoperative stenting differed by stone location: pre-stenting improved SFR and decreased complications in renal stone treatment, but not in ureteric stone treatment [7]. Given that our cohort predominantly included ureteral stones (68.7%) and used a relatively permissive SFR definition of residual fragments ≤ 4 mm, the lack of a significant SFR benefit may be clinically plausible.

Although pre-stenting itself was not associated with postoperative fever in our cohort, prolonged stent dwell time has been repeatedly reported as a risk factor for infectious complications after ureteroscopy. Prior studies have demonstrated that postoperative infectious complications increase substantially with longer stent dwell times, with infection rates rising markedly beyond one month of indwelling time [12]. Similarly, Hanna et al. found that pre-lithotripsy UTI occurred in only 4.3% of patients with a stent dwell time of less than 1 month, compared with 26.2% in those with a dwell time longer than 1 month [8].

The 30-day cutoff used in the present study was selected based on both clinical relevance and previous evidence, representing a clinically meaningful and literature-supported threshold rather than an arbitrary value.

In the present study, patients with positive preoperative urine cultures received culture-directed antibiotics before surgery. This perioperative management may have reduced the risk of postoperative febrile events and partly explains why pre-stenting and longer dwell time were not significantly associated with postoperative fUTI. However, urine culture may not fully reflect bacterial colonization of the ureteral stent. Tulone et al. reported that proximal and distal stent cultures were positive in 82.5% and 78.4% of cases, respectively, whereas selective renal pelvis urine cultures were positive in only 21.6% of patients [5], suggesting discordance between urine and stent cultures, and more aggressive perioperative management strategies may warrant further investigation.

This study has several limitations. First, this was a retrospective multicenter study, and treatment strategies, surgical techniques, access sheath use, and perioperative antibiotic protocols may have differed among institutions, introducing potential heterogeneity. In addition, various reusable and disposable ureteroscopes, ureteral access sheaths of different sizes and manufacturers, and laser systems were used according to institutional practice and surgeon preference. These technical variations could have influenced operative outcomes and were not fully accounted for in the present analysis. Second, although IPTW was used to adjust for measured baseline differences, unmeasured confounders, including surgeon experience, institutional policy, access difficulty, and detailed reasons for stent placement, could not be fully controlled. Third, the definition of SFR in this study allowed residual fragments ≤ 4 mm, which is less stringent than definitions used in some previous studies and may have reduced the ability to detect small differences in stone clearance. Fourth, although patients with positive preoperative urine cultures received culture-directed antibiotics before surgery, detailed information on antibiotic duration, adherence, and postoperative antibiotic use was limited; therefore, residual bias related to infection prevention cannot be excluded. Fifth, postoperative outcomes were primarily focused on febrile events. Other clinically relevant complications, particularly ureteral injury, access-related trauma, and other procedure-related adverse events, were not comprehensively evaluated. Therefore, the potential impact of pre-stenting and stent dwell time on these outcomes remains unclear. Finally, the number of postoperative febrile events was relatively small, limiting the statistical power for subgroup analyses, especially analyses according to stent dwell time.

In conclusion, preoperative ureteral stenting was associated with shorter operative time but was not associated with improved SFR or increased postoperative fever after adjustment for baseline differences. These findings suggest that routine pre-stenting may not be necessary in patients without clear clinical indications. When pre-stenting is required, prolonged dwell time should be minimized whenever feasible.

Abbreviations

Pre-stenting: Preoperative ureteral stenting

SFR: Stone Free Rate

TUL: transurethral lithotripsy

Declarations

Ethics approval and consent to participate

The study protocol was approved by the Ethics Committee of the Institutional Review Board of The Jikei University School of Medicine (Approval No. 36–005[12104]). The requirement for informed consent was waived owing to the retrospective nature of the study. The study was conducted in accordance with the Declaration of Helsinki.

Consent for publication

Not applicable.

Availability of data and materials

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

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

YY conceived and designed the study. YY and SK drafted the manuscript. All authors contributed to data collection, data interpretation, and critical revision of the manuscript. TK supervised the study. All authors read and approved the final manuscript.

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Clinical Trial Number

Clinical trial number: not applicable.

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Figures

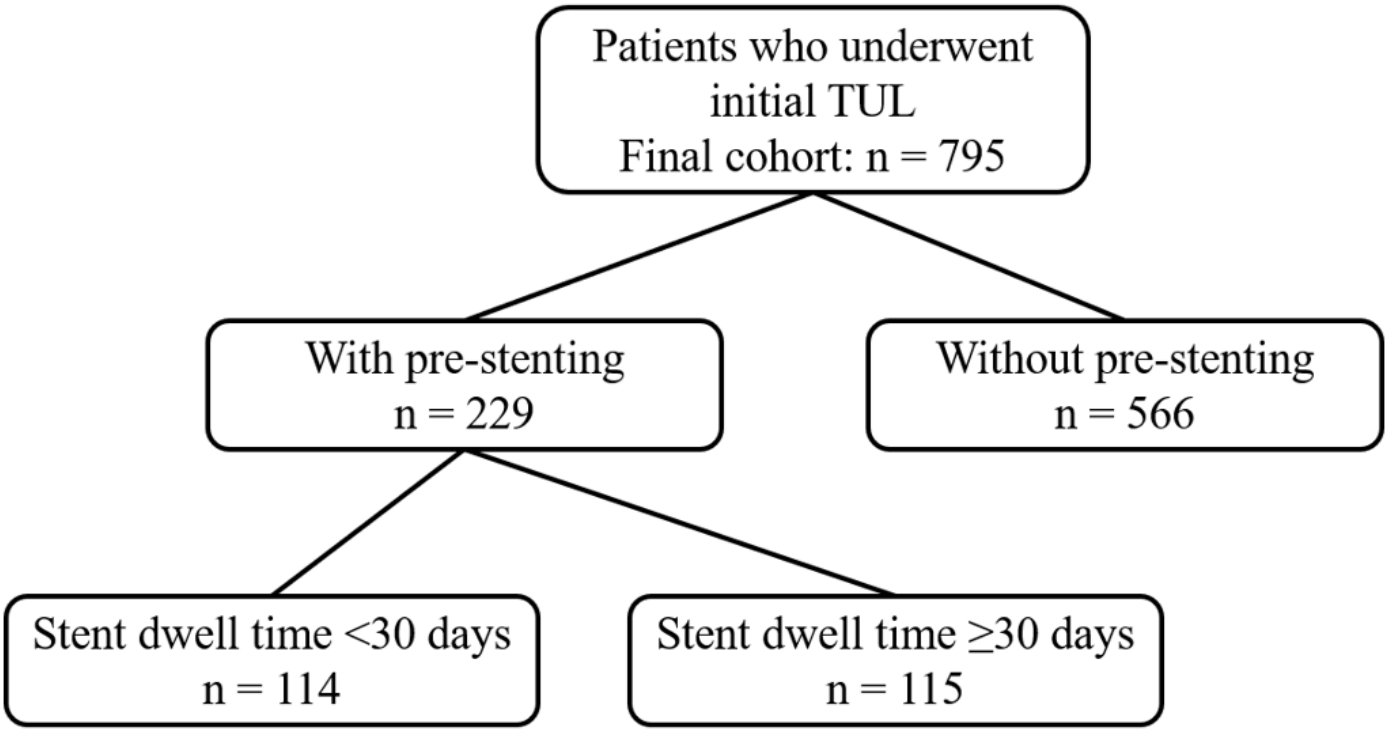


Figure 1

Study flow diagram.

A total of 795 patients who underwent initial TUL for renal or ureteral stones between January 2023 and December 2024 were included. Patients were divided into pre-stenting and non-stenting groups. Additional subgroup analyses according to stent dwell time (<30 vs ≥30 days) were performed in pre-stented patients.

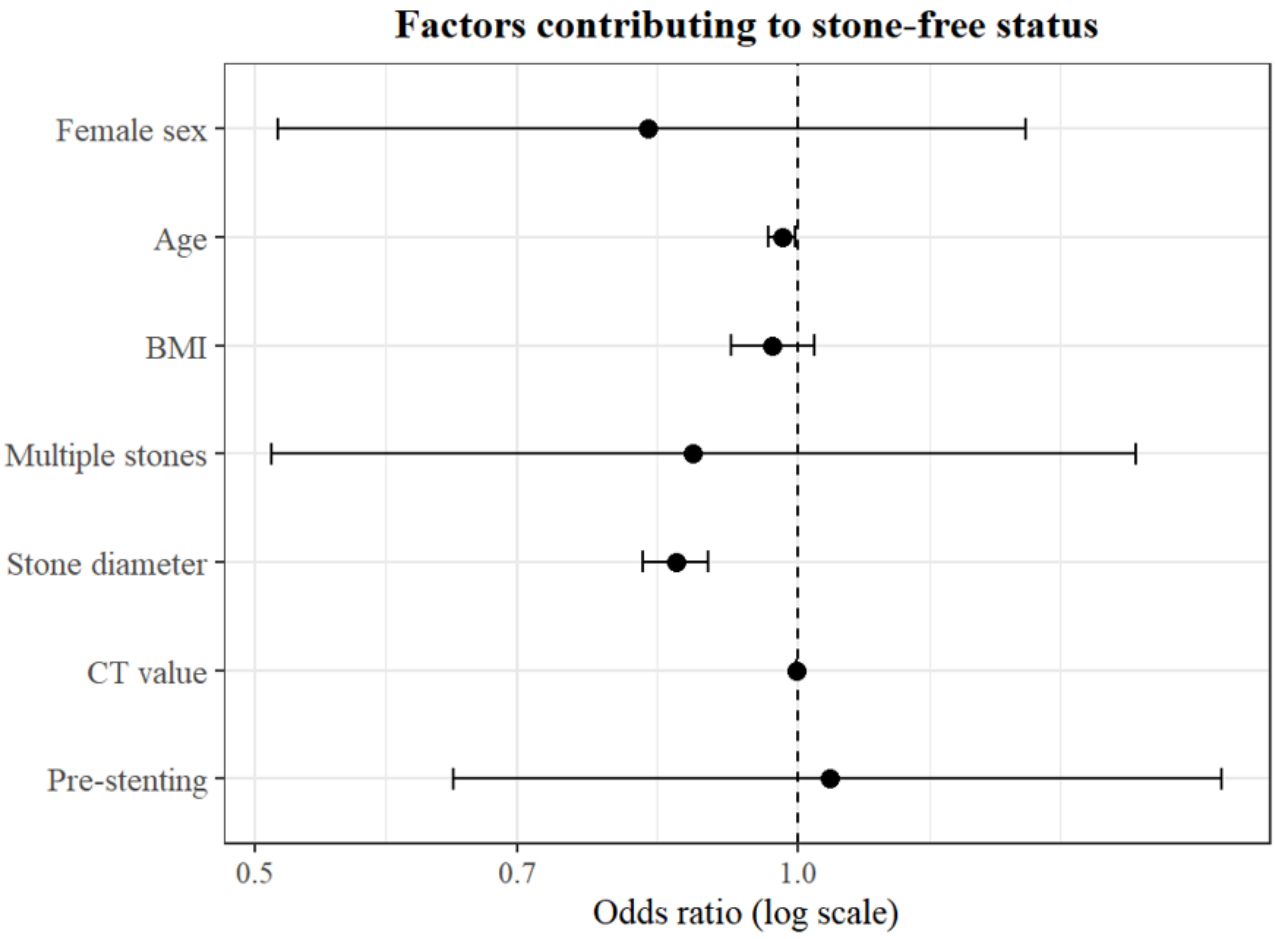


Figure 2

Multivariable logistic regression analysis for predictors of stone-free status (SFR).

Forest plot showing odds ratios and 95% confidence intervals for factors associated with SFR after TUL.

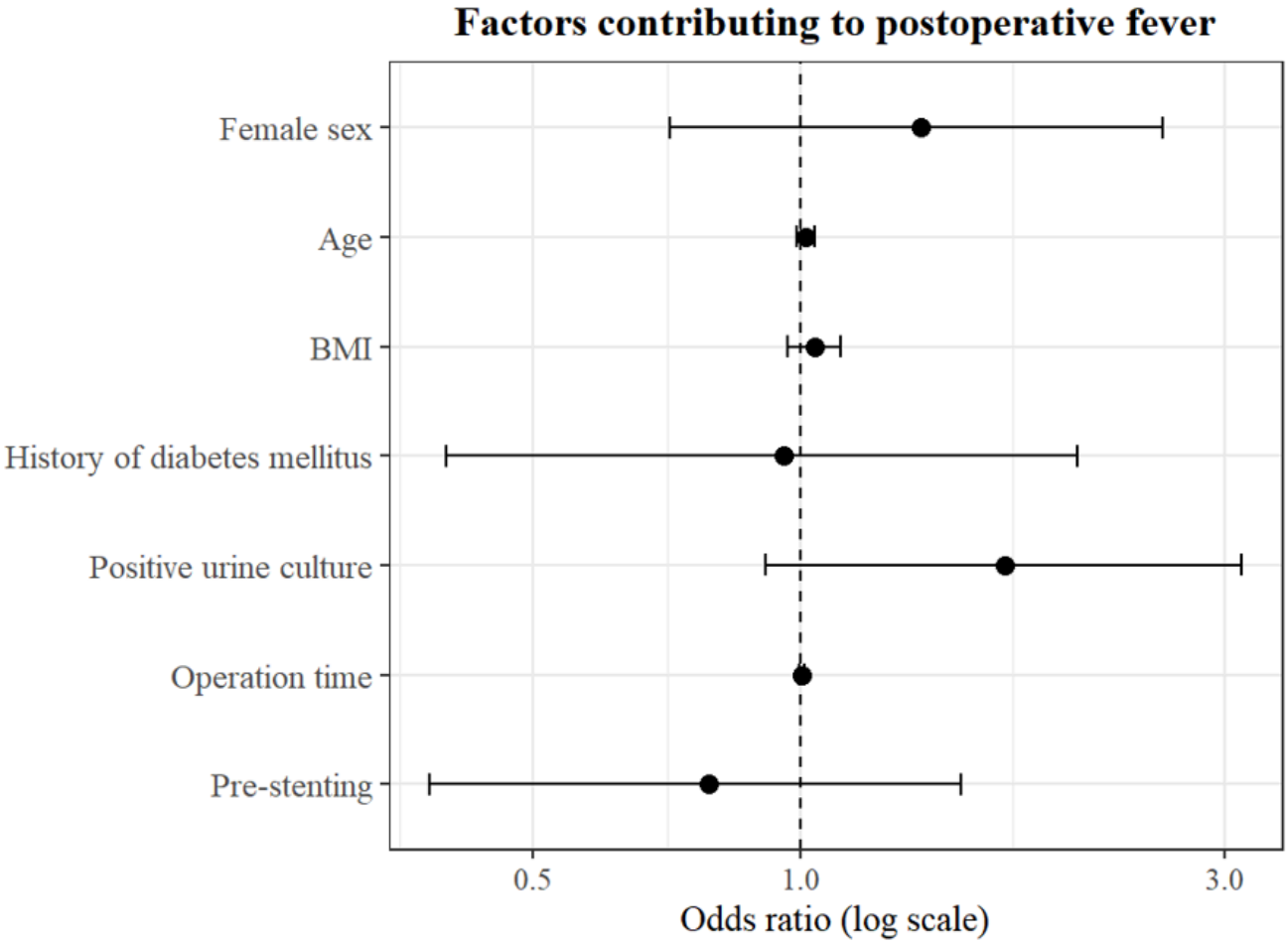


Figure 3

Multivariable logistic regression analysis for predictors of postoperative febrile urinary tract infection (fUTI).

Forest plot showing odds ratios and 95% confidence intervals for factors associated with postoperative febrile events after TUL.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- SupplementaryTable1.docx