ORIGINAL PAPER

UROLITHIASIS

Impact of preoperative ureteral stenting on perioperative outcomes in percutaneous nephrolithotomy

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Citation: Ebner B, Guo T, Bauer J, et al. Impact of preoperative ureteral stenting on perioperative outcomes in percutaneous nephrolithotomy. Cent European J Urol. 2026; 79: 367-374.

Article history
Submitted: Nov. 17, 2025
Accepted: Apr. 10, 2026
Published online: Jul. 7, 2026

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Introduction The impact of preoperative ureteral stenting on perioperative outcomes in percutaneous nephrolithotomy (PCNL) remains unexplored. This study addresses this knowledge gap to guide evidence-based clinical practice.

Material and methods We retrospectively analyzed consecutive PCNL patients treated at LMU University Hospital Munich between December 2012 and April 2025 (n = 374), and compared perioperative outcomes between prestented and non-prestented patients. Patients who underwent endoscopic combined intrarenal surgery (ECIRS, n = 154) or simultaneous bilateral endoscopic surgery (SBES, n = 23) were excluded to avoid confounding from concurrent ureteroscopy.

Results A total of 197 PCNL patients were included (median age 55 years, 64% male). Preoperative ureteral stenting was performed in 78 patients (40%), while 119 patients (60%) underwent PCNL without prestenting. No significant differences were observed between the two groups regarding age, gender, BMI, ASA score, stone radiodensity, or stone composition. Guy's Stone Score did not differ significantly between groups (median 2, IQR 1–3; p = 0.221), although prestented patients had a slightly higher stone count. Operative time (103 vs 97 minutes; p = 0.814) and complication rates (10% vs 11%; p = 0.963) were similar, with fever being the most common complication. Radiation exposure, laboratory parameters, and hospital stay did not differ between groups. On multivariable logistic regression, prestenting (OR = 2.83, 95% CI: 1.09–7.38; p = 0.033), longer operative time, Guy's Stone Score 4, and greater stone number were independent predictors of not achieving stone-free status.

Conclusions Unless urgently indicated, preoperative ureteral stenting before PCNL should be omitted, because it confers additional procedural burden and stent-related morbidity without improving perioperative outcomes.

Key Words: percutaneous nephrolithotomy (PNL) ‹› ureteral stent ‹› urolithiasis ‹› perioperative outcomes ‹› postoperative complications

INTRODUCTION

Percutaneous nephrolithotomy (PCNL) is widely recognized as the first-line treatment for large renal calculi, offering high stone clearance rates through a minimally invasive approach [1]. PCNL practices differ considerably worldwide and are shaped by regional, economic, and experience-related factors [2].

Technical aspects of PCNL have been continuously refined [3, 4], including patient positioning [5, 6], imaging [7], tract dilation technique [8–10], miniaturization of access tracts and instrument diameters [11], lithotripsy devices [12, 13], and digital integration of navigation systems, robotics, and artificial intelligence [14]. Despite these advances, one fundamental aspect of perioperative management remains poorly understood: the impact of preoperative ureteral stenting.

While clear evidence supports prestenting for most ureteroscopy indications [15–17], no comparable evidence exists for PCNL. The clinical implications of prestenting for PCNL must be considered from multiple perspectives. On one hand, preoperative stenting is mandatory in certain scenarios, such as infected hydronephrosis due to obstructing renal calculi. Furthermore, prestenting may facilitate ureteroscopic access, enabling a combined endourological approach to address otherwise inaccessible renal stones and thereby potentially avoiding additional percutaneous tracts [18]. On the other hand, prestenting represents an additional intervention with inherent procedural risks, frequently causes stent-related symptoms [19] and may increase the risk of infectious complications [20].

Despite the clinical relevance of this question, no systematic evaluation has examined whether prestenting influences perioperative PCNL outcomes. This study addresses this knowledge gap by comparing prestented and non-prestented PCNL patients regarding operative efficiency, stone-free rates, postoperative complications, and laboratory parameters.

MATERIAL AND METHODS

Study design and patient cohort

This retrospective cohort study was conducted at the Department of Urology of the LMU University Hospital in Munich, Germany. We performed an analysis of all consecutive patients who underwent PCNL between December 2012 and April 2025 at our institution. All PCNL patients were included in the analysis, regardless of stone characteristics or patient-specific factors. Patients who underwent endoscopic combined intrarenal surgery (ECIRS) or simultaneous bilateral endoscopic surgery (SBES) were excluded, as concurrent ureteroscopy or bilateral prestenting would confound postoperative outcomes. Patient data and clinical outcomes were obtained from medical records.

All PCNL procedures were performed by endourology surgeons using either Storz or Richard Wolf instruments, based on the surgeon's discretion. The laser systems employed included a holmium:yttrium-aluminum-garnet (Ho:YAG) laser (Medilas, Dornier) and a pulsed thulium:yttrium-aluminum-garnet (Tm:YAG) laser (Thulio, Dornier), with laser selection based on the surgeon's discretion and daily availability. Mechanical lithotripters were not used in this study. Patients were operated on in either prone or supine position, depending on the surgeon's preference. Renal puncture was performed under both sonographic and fluoroscopic guidance. A urethral catheter was placed in all patients following PCNL. Nephrostomy tube and ureteral stent placement was performed at the discretion of the treating surgeon. In some cases, the ureteral stent was placed with an extraction string that was attached to the urethral catheter. When a ureteral stent was connected to the catheter via string, it was removed prior to discharge. Patients remained hospitalized until nephrostomy tube removal.

Stone-free status was evaluated by intraoperative endoscopic and fluoroscopic assessment as well as postoperative ultrasound examination. In our department, computed tomography (CT) scan is performed only in cases of suspected residual stone burden and is not used routinely. Laboratory parameters were assessed preoperatively and on the first postoperative day, including serum creatinine, estimated glomerular filtration rate (eGFR), leukocyte count, C-reactive protein, and hemoglobin. Complications were classified according to the Clavien–Dindo classification system. Stone complexity was assessed using the Guy's Stone Score, number of stones, largest stone diameter (measured in axial, sagittal, and coronal planes on CT), and radiodensity of the largest stone (Hounsfield units).

Statistical analysis

Continuous variables were shown as median with interquartile range (IQR) and categorical variables were shown as proportions. A two-tailed t-test for independent samples was performed for comparisons between continuous variables. Before every t-test, a Levene test was performed to assess equality of variance. A χ^2 test was performed for comparisons between categorical variables. Fisher's exact test was applied when the assumptions for the χ^2 test were not met. The Mann-Whitney U test was used to compare ordinal data between two independent groups. Significance levels were set at 5%. All statistical analyses were conducted with numiqo Team (DATAtab e.U. Graz, Austria).

Bioethical standards

The study adhered to the ethical principles of the Declaration of Helsinki and was approved by the Ethics Committee of the Ludwig Maximilians University Munich (project number: 22-0949, date of approval: 13.01.2023).

RESULTS

Baseline characteristics

Between December 2012 and April 2025, a total of 374 patients underwent PCNL at our institution. Of these, 177 patients were excluded based on predefined criteria, including 154 ECIRS procedures and 23 SBES procedures. The final study cohort comprised 197 patients who underwent conventional PCNL. Preoperative ureteral stenting was performed in 78 patients (40%), while 119 patients (60%) underwent PCNL without prestenting. The median duration of prestenting was 36.5 days (IQR: 21–72).

Baseline characteristics of the study population are summarized in Table 1. The median age was 55 years (IQR: 43–68), and 64% of patients were male. No significant differences were observed between prestented and non-prestented patients regarding age (54 vs 56.5 years; p = 0.759), gender distribution (61% vs 66% male; p = 0.544), BMI (25.5 vs 26.0 kg/m²; p = 0.610), or ASA class (ASA class >2: 29% vs 30%; p = 0.944).

Stone complexity assessed by Guy's Stone Score did not differ significantly between groups (median 2, IQR 1–3; p = 0.221). However, prestented patients had a significantly higher number of stones (median 1, IQR 1–3 vs 1, IQR 1–2; p = 0.003). The size of the largest stone showed no significant differences across all three measured planes: coronal (15.5 vs 19 mm; p = 0.097), sagittal (14 vs 14 mm; p = 0.494), and transverse (13.5 vs 17 mm; p = 0.115). Stone radiodensity was comparable between groups, with maximum values of 1,175 vs 1,200 HU (p = 0.683) and mean values of 850 vs 900 HU (p = 0.163). The predominant stone composition was calcium oxalate (55%), followed by carbonate apatite (21%) and uric acid (11%), with no significant differences in distribution between groups.

Perioperative outcomes

Perioperative outcomes of the study population are summarized in Table 2. Patient positioning (prone 64% vs 60%; p = 0.530), number of percutaneous accesses (median 1 in both groups; p = 0.939), and laser type used (Ho:YAG 91% vs 88%; p = 0.802) did not differ between groups. Operative time was similar between prestented and non-prestented patients

Table 1. *Baseline characteristics of patients undergoing PCNL with or without prestenting. Continuous variables are presented as median with interquartile range (IQR), categorical variables as proportions*

Characteristics	All n = 197 (100%)	Prestented n = 78 (40%)	Non-prestented n = 119 (60%)	p
Prestenting duration (days)	–	36.5 (21–72)	–	–
Age (years)	55 (43–68)	54 (45–68)	56.5 (43–69)	0.759
Gender				
Male	64% (126/197)	61% (47/77)	66% (79/120)	0.544
Female	36% (71/197)	39% (30/77)	34% (41/120)	
BMI (kg/m²)	25.8 (23.3–29.0)	25.5 (23.8–28.7)	26.0 (23.2–29.3)	0.610
ASA class >2	30% (52/175)	29% (20/68)	30% (32/107)	0.944
Guy’s Stone Score	2 (1–3)	2 (1–3)	2 (1–3)	0.221
Number of stones	1 (1–2)	1 (1–3)	1 (1–2)	**0.003**
Size of largest stone (mm)				
Coronal plane	18 (13–25)	15.5 (12–22)	19 (14–26)	0.097
Sagittal plane	14 (9–19)	14 (10–19)	14 (9–19)	0.494
Transverse plane	15 (11–21)	13.5 (11–21)	17 (11–21)	0.115
Radiodensity of largest stone (HU)				
Maximum	1,200 (850–1,500)	1,175 (900–1,450)	1,200 (850–1,500)	0.683
Mean	900 (700–1,200)	850 (700–1,100)	900 (700–1,200)	0.163
Predominant stone component				
Calcium oxalate	55% (88/161)	51% (30/59)	57% (58/102)	
Carbonate apatite	21% (34/161)	27% (16/59)	18% (18/102)	
Uric acid	11% (17/161)	8% (5/59)	12% (12/102)	
Struvite	6% (10/161)	7% (4/59)	6% (6/102)	–
Cystine	4% (7/161)	5% (3/59)	4% (4/102)	
Calcium phosphate	2% (4/161)	0% (0/59)	4% (4/102)	
Ammonium urate	1% (1/161)	2% (1/59)	0% (0/102)	

ASA – American Society of Anesthesiologists; BMI – body mass index; HU – Hounsfield units

(103 vs 96.5 minutes; p = 0.814). The stone-free rate was slightly lower in prestented patients (68% vs 81%; p = 0.061), without reaching statistical significance. Fluoroscopy time (3.1 vs 3.4 minutes; p = 0.939) and dose area product (380.7 vs 333.3 cGy/cm²; p = 0.611) were comparable. Interestingly, comparing long vs short preoperative DJ stent indwelling times using the median duration as a cut-off (37 days (IQR 21–72)) revealed no significant differences in operative outcomes or postoperative complications (Suppl. Table 1). Furthermore, a multivariable logistic regression model was constructed to determine independent predictors of stone-free status, incorporating prestenting status, ASA class, operative time, patient positioning, Guy's Stone Score, number of stones, and positive urine culture at admission as covariates. Preoperative ureteral stenting (OR = 2.83, 95% CI: 1.09–7.38, p = 0.033), prolonged operative time (OR = 1.02 per minute, 95% CI: 1.01–1.04, p = 0.008), Guy's Stone

Table 2. *Perioperative outcomes of patients undergoing PCNL with or without prestenting. Continuous variables are presented as median with interquartile range (IQR), categorical variables as proportions*

Characteristics	All n = 197 (100%)	Prestented n = 78 (40%)	Non–prestented n = 119 (60%)	p
Patient positioning				
Prone position	62% (121/196)	64% (49/76)	60% (72/120)	0.530
Supine position	38% (75/196)	36% (27/76)	40% (48/120)	
Number of percutaneous accesses	1 (1–1)	1 (1–1)	1 (1–1)	0.939
Laser				
Ho:YAG	89% (156/175)	91% (58/64)	88% (98/111)	0.802
Tm:YAG	11% (19/175)	9% (6/64)	12% (13/111)	
Operative time (min)	101 (67–127)	103 (68–121)	96.5 (65–129)	0.814
Stone–free rate	76% (147/194)	68% (52/76)	81% (95/118)	0.061
Fluoroscopy time (min)	3.2 (2.3–5.0)	3.1 (2.3–4.6)	3.4 (2.3–5.1)	0.939
Dose area product (cGy/cm²)	369.8 (11.3–841.3)	380.7 (28.7–730.2)	333.3 (6.2–920.0)	0.611
Postoperative ureteral stent	92% (182/197)	92% (71/77)	92% (111/120)	0.302
Duration postoperative stenting (days)	19 (10–35)	18 (10–29)	21 (7–37)	0.568
Postoperative nephrostomy	74% (145/197)	73% (56/77)	74% (89/120)	0.982
Nephrostomy duration (days)	2 (1–3)	2 (2–4)	2 (1–3)	**0.019**
Clavien–Dindo complications				
No complications	89% (175/196)	90% (69/77)	89% (106/119)	
Minor (I–II)	6% (12/196)	5% (4/77)	7% (8/119)	0.963
Major (III–IV)	5% (9/196)	5% (4/77)	4% (5/119)	
Postoperative fever	5% (10/195)	7% (5/76)	4% (5/119)	0.463
Blood transfusion	0% (0/196)	0% (0/77)	0% (0/119)	1.000
Length of stay (days)	4 (3–6)	4 (3–6)	4 (3–6)	0.224

Table 3. *Laboratory parameters of patients undergoing PCNL with or without prestenting. Continuous variables are presented as median with interquartile range (IQR), categorical variables as proportions*

Characteristics	All n = 197 (100%)	Prestented n = 78 (40%)	Non–prestented n = 119 (60%)	p
Positive urine culture on admission	33% (51/154)	35% (22/63)	32% (29/91)	0.692
Creatinine change (mg/dl)	0.0 (from –0.1 to 0.1)	0.0 (from –0.1 to 0.1)	0.1 (from 0.0 to 0.2)	0.770
GFR change (ml/min)	–2 (from –11 to 3)	0 (from –7 to 5)	–5.5 (from –12 to 1)	**0.001**
Leukocytes change (G/l)	2.1 (from 0.8 to 4.4)	1.6 (from 0.1 to 3.6)	2.4 (from 1.1 to 4.8)	**0.042**
CRP change (mg/dl)	1.9 (from 0.9 to 4.9)	1.8 (from 0.6 to 5.7)	1.9 (from 1.0 to 4.2)	0.509
Hemoglobin change (g/dl)	–0.9 (from –1.6 to –0.4)	–0.9 (from –1.5 to –0.4)	–1.0 (from –1.7 to –0.6)	0.200

CRP – C–reactive protein; GFR – glomerular filtration rate

Score 4 (OR = 29.86, 95% CI: 3.28–271.70, p = .003), and a higher number of stones (OR = 1.35, 95% CI: 1.00–1.81, p = .049) proofed as independent predictors of failure to achieve stone-free status (Supp. Table 2). Postoperative ureteral stent placement was performed in 92% of patients in both groups (p = 0.302), with similar stenting durations (18 vs 21 days; p = 0.568). Postoperative nephrostomy was placed in 73% vs 74% of patients (p = 0.982), with a marginally longer nephrostomy duration observed in the prestented group, which reached statistical significance (2 days, IQR 2–4 vs 2 days, IQR 1–3; p = 0.019).

Complication rates according to Clavien–Dindo classification were similar (10% vs 11%; p = 0.963). Most complications were minor, with fever being the most common in both groups (7% vs 4%; p = 0.463). No blood transfusions were required in either group. Length of hospital stay was identical between groups (4 days, IQR 3–6; p = 0.224).

Laboratory characteristics

Laboratory characteristics of the study population are summarized in Table 3. Microbial growth in urine cultures obtained at admission was found in 33%, with no difference between prestented and non-prestented patients (35% vs 32%, p = 0.692). Changes in laboratory parameters after PCNL were minimal, with no clinically relevant differences between both groups. Creatinine levels remained stable (0.0 vs 0.1 mg/dl; p = 0.770), while GFR showed a minor decline (0 vs –5.5 ml/min; p = 0.001). Leukocyte counts increased postoperatively (1.6 vs 2.4 G/l; p = 0.042), C-reactive protein levels rose minimally (1.8 vs 1.9 mg/dl; p = 0.509), and hemoglobin decreased slightly (–0.9 vs –1.0 g/dl; p = 0.200).

DISCUSSION

This study assessed the impact of preoperative ureteral stenting on perioperative outcomes in patients undergoing PCNL and found no significant effect on key procedural endpoints.

Operative times were similar between prestented and non-prestented patients, suggesting that prestenting does not enhance procedural efficiency. Furthermore, complication rates were comparable between groups, with fever being the most frequently observed complication. In the comparison of postoperative laboratory parameters, a slightly greater decline in glomerular filtration rate was observed in patients without prestenting following PCNL (–5.5 ml/min vs 0 ml/min, p = 0.001), as well as a modestly higher increase in leukocyte count in patients undergoing PCNL without prior prestenting compared to those with prestenting (2.4 G/l vs 1.6 G/l, p = 0.042). Given the overall minimal postoperative changes in laboratory parameters after PCNL, these differences are most likely of questionable to negligible clinical relevance. The slightly lower stone-free rate in prestented patients, which approached but did not reach statistical significance, is likely attributable to the higher stone count observed in this group rather than the stenting itself. Patients with multiple stones or more complex stone configurations may have been more likely to receive preoperative stenting based on surgeon preference or perceived procedural complexity. This finding should therefore be interpreted in the context of their higher stone burden rather than as a direct consequence of prestenting. Laboratory parameters showed minimal changes postoperatively, with no clinically relevant differences between groups. Although statistically significant differences were observed in some parameters, the absolute values remained well within safe limits and did not translate into differences in clinical outcomes such as infectious complications.

Importantly, preoperative ureteral stenting is not a benign intervention. Stent-related symptoms, including dysuria, urgency, flank pain, and hematuria, are well-documented and can significantly impact patient quality of life [19, 21]. Additionally, stent placement requires a separate endoscopic procedure with associated risks, including ureteral injury, anesthesia-related complications and infection [20]. Given that our results show no measurable benefit from prestenting in terms of operative outcomes or complication rates, the routine use of preoperative stents appears difficult to justify from a risk-benefit perspective. Our findings therefore support a selective approach to preoperative ureteral stenting, reserving it for specific clinical scenarios such as infected obstructive uropathy. In the absence of such indications, proceeding directly to PCNL without prestenting appears safe and may be preferable to avoid unnecessary interventions. With modern, increasingly thinner ureteroscopes, atraumatic ureteral access can often be achieved without prior stenting [22], questioning the necessity of routine prestenting even in combined procedures (ECIRS or SBES).

Several limitations of this study warrant consideration. First, the retrospective design introduces inherent selection bias, as the decision to place a preoperative stent was made at the treating surgeon's discretion rather than through randomization. Although we observed similar baseline characteristics, the higher stone count in prestented patients might suggest that selection bias influenced stenting decisions. Second, stone-free status was assessed by intraoperative endoscopic and fluoroscopic evaluation as well as postoperative ultrasound rather than computed tomography, which may have underestimated residual stone burden. Third, encrustation of a ureteral stent may influence both the surgical procedure and the postoperative course. However, we are unable to provide information on the condition of the ureteral stents in our study cohort. Fourth, the specific indication for preoperative ureteral stent placement (e.g., obstruction, infection, or procedural facilitation) could not be clearly determined. Finally, no formal a priori sample size or power calculation was performed, as this study included all consecutive eligible patients treated during the study period. Although effect estimates are reported with corresponding 95% confidence intervals, the study may have limited precision to detect small but potentially clinically meaningful differences, particularly in subgroup analyses.

CONCLUSIONS

In our study, preoperative ureteral stenting had no significant impact on key PCNL outcomes, including procedural efficiency, complication rates, and stone-free rates. In the absence of urgent indications such as infected obstructive uropathy, prestenting can therefore be safely omitted, avoiding an additional intervention as well as stent-related discomfort and infection risk.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

FUNDING

This research received no external funding.

ETHICS APPROVAL STATEMENT

The study was conducted in accordance with the ethical standards of the Declaration of Helsinki and approved by the Ethics Committee of the Ludwig Maximilians University Munich (project number: 22-0949, date of approval: 13.01.2023).

SUPPLEMENTARY MATERIALS

Suppl. Table 1. *Baseline characteristics and outcomes of patients undergoing PCNL with prestenting and prolonged indwelling time of the ureteral stent (cut-off: median indwelling time of all patients). Continuous variables are presented as median with interquartile range (IQR), categorical variables as proportions*

Characteristics	Prestenting <36.5 days	Prestenting ≥36.5 days	p
	n = 31 (51%)	n = 30 (49%)	
Age (years)	54 (45–71.5)	57 (42.75–67.75)	0.974
Gender			
Male	61% (19/31)	57% (17/30)	0.714
Female	39% (12/31)	43% (13/30)	
BMI (kg/m²)	26 (24.5–28.7)	25.2 (23.4–29.8)	0.993
ASA class >2	32% (8/25)	28% (8/29)	0.723
Guy's Stone Score	2 (1–2)	2 (1–3)	0.299
Number of stones	1 (1–2.25)	2 (1–2.25)	0.318
Size of largest stone (mm)			
Coronal plane	14 (12–19)	16 (12–21.25)	0.308
Sagittal plane	14 (9–17)	12 (9.5–17.5)	0.849
Transverse plane	15 (11–18)	11.5 (10.75–21.75)	0.867
Radiodensity of largest stone (HU)			
Maximum	1,200 (800–1,400)	1,100 (887.5–1,500)	0.508
Mean	900 (650–1,200)	800 (637.5–1,200)	0.824
Patient positioning			
Prone position	74% (23/31)	47% (14/30)	**0.037**
Supine position	26% (8/31)	53% (16/30)	
Number of percutaneous accesses	1 (1–1)	1 (1–1)	0.327
Laser			
Ho:YAG	92% (22/24)	86% (25/29)	0.678
Tm:YAG	8% (2/24)	14% (4/29)	
Operative time (min)	108 (91–121)	94.5 (64.75–128.25)	0.767
Stone-free rate	83% (25/30)	60% (18/30)	0.084

Suppl. Table 1. *Continued*

Characteristics	Presenting <36.5 days	Presenting ≥36.5 days	p
	n = 31 (51%)	n = 30 (49%)	
Fluoroscopy time (min)	3.15 (2.28–4.93)	3.31 (2.42–5.17)	0.227
Dose area product (cGy/cm²)	440 (33.4–919.38)	289.06 (18.6–682.38)	0.333
Postoperative ureteral stent	94% (29/31)	97% (29/30)	1.000
Duration postoperative stenting (days)	19.5 (11.5–26.75)	13.5 (6.25–24.5)	0.720
Postoperative nephrostomy	65% (20/31)	73% (22/30)	0.457
Nephrostomy duration (days)	2 (1.25–3)	2 (2–3)	0.913
Clavien–Dindo complications			
No complications Minor (I–II) Major (III–IV)	90% (28/31) 3% (1/31) 6% (2/31)	90% (27/30) 7% (2/30) 3% (1/30)	1.000
Postoperative fever	3% (1/31)	10% (3/29)	0.346
Blood transfusion	0% (0/31)	0% (0/30)	1.000
Length of stay (days)	4 (3–5)	4 (3–6)	0.600

ASA – American Society of Anesthesiologists; BMI – body mass index; HU – Hounsfield units

Suppl. Table 2. *Multivariable logistic regression analysis of predictors of residual stone burden after PCNL*

Variable	OR	95% CI	p
Presenting (Yes)	2.83	1.09–7.38	0.033
ASA class >2	1.56	0.54–4.55	0.411
Operative time (min)	1.02	1.01–1.04	0.008
Patient positioning (supine)	1.63	0.46–5.76	0.449
Guy's Stone Score 2	2.69	0.56–12.81	0.214
Guy's Stone Score 3	3.97	0.91–17.43	0.067
Guy's Stone Score 4	29.86	3.28–271.70	0.003
Number of stones	1.35	1.00–1.81	0.049
Positive urine culture	1.90	0.71–5.09	0.200

CI – confidence interval; OR – odds ratio for not achieving stone-free status
Reference category for Guy's Stone Score: Grade 1

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