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Complications in emergency ureteroscopy for ureteral stone treatment: A retrospective study

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Summary

Background: *Data on complications associated with emergency ureteroscopy for ureteral stones are limited, particularly in developing countries.*
This study investigates factors contributing to complications in emergency ureteroscopy utilizing a pneumatic semirigid ureteroscope (URS).
Materials and methods: *This retrospective analysis included 266 patients with ureteral stones who underwent emergency ureteroscopy using a pneumatic semirigid URS from 2018 to 2023. We extracted comprehensive data on patient demographics, stone characteristics, intraoperative and postoperative complications, and stone-free rate (SFR) from medical records, subsequently subjected to statistical analysis. Factors linked to complications were explored through univariate and multivariate analyses.*
Results: *The mean stone size was 9.1 ± 4.9 mm, with the majority (n = 181, 71.3%) located in the mid-ureter. The mean operative duration was 57.7 ± 7.3 minutes. The overall complication rate was 10.2%, with intraoperative complications in 16 patients (6.0%), including mucosal damage (3.4%), stone up-migration (3.0%), and one ureteral perforation (0.4%). Postoperative complications occurred in 13 patients (4.9%), primarily fever (2.6%), followed by hematuria (1.1%). Additional complications included febrile urinary tract infections (UTIs), pyelonephritis, and one mortality. The overall SFR was 85.3%, with 39 patients (14.7%) demonstrating residual stones. Significant predictive factors for complications included larger stone size (Adjusted Odds Ratio [AOR]: 1.3; 95% Confidence Interval [CI]: 1.15-1.39, p < 0.0001) and proximal ureteral stones (AOR: 4.9; 95% CI: 1.31-18.23, p = 0.0182).*
Conclusions: *Emergency ureteroscopy using a semirigid URS demonstrated favorable outcomes in treating ureteral stones, characterized by minimal complications and an acceptable SFR. Emphasizing appropriate instrument selection, surgical expertise, and technique is crucial in minimizing adverse events, particularly for large and upper ureteral stones.*

KEY WORDS: *Emergency ureteroscopy, Pneumatic semirigid ureteroscope, Surgical complications, Ureteral stones, Urolithiasis.*

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INTRODUCTION

Ureteral stones represent a significant and growing public health burden, necessitating timely and effective interventions due to the acute pain associated with ureteric colic, classifying it as a urological emergency (1, 2). Recent global estimates highlight the prevalence of urolithiasis, emphasizing the increasing need for efficient and safe treatment strategies (1). As the incidence of ureteral stones varies, the need for emergency intervention due to acute obstruction becomes a consistent clinical challenge.

Advances in endourological techniques, particularly emergency *ureteroscopy* (URS) using semirigid ureteroscopes, have revolutionized the management of ureteral stones (3, 4). Emergency URS, defined by the immediate intervention required to address acute ureteral obstruction and its associated complications, has become a primary modality for diagnosis and treatment, including ureteroscopic lithotripsy (3, 5). This shift towards minimally invasive approaches has improved patient outcomes; however, it is crucial to acknowledge and address the potential for adverse events, especially in emergency settings where patient acuity, the degree of obstruction, and resource availability may impact outcomes (3).

The use of pneumatic lithotripsy is a common method for stone fragmentation.

The spectrum of adverse events associated with emergency URS ranges from minor, such as mucosal abrasions and stone migration, to more severe events like ureteral perforation or avulsion (3, 4). While advancements in URS technology and surgical techniques have improved stone-free rates (approaching 90-97%), the emergency nature of the procedure can influence the incidence and severity of complications (4-6). Specifically, in the setting of acute obstruction, challenges include increased tissue edema, altered ureteral anatomy, and the potential for infection, which may affect the surgeon's ability to manage the stones.

Prior research has identified several factors associated with adverse events in URS for ureteral stone treatment (4, 6-9). These include stone characteristics (size, density, location), patient-specific variables (age, comorbidities, and anatomy), and procedural factors (instrument type, surgical experience, and the presence of infection). In the context of emergency URS, the interplay of these factors requires specific investigation to optimize patient care. Despite the importance of this topic, there is a relative lack of research focusing on adverse events in emergency URS settings, particularly within the context of resource-limited environments. This study aims to ana-

lyze the adverse events and predictive factors associated with emergency ureteroscopy using a pneumatic semirigid URS for ureteral stones, with the goal of improving treatment efficacy, enhancing patient safety, and developing targeted strategies to mitigate the risk of complications. The findings of this study may inform clinical practice guidelines, improve patient counseling, and optimize resource allocation in emergency urological care.

Materials and methods

Study design and setting

This retrospective study was conducted at Ibb University Hospitals, Ibb, Yemen. The study cohort comprised 266 patients who underwent emergency *transurethral ureterolithotripsy* (TUL) using semirigid ureteroscopes from November 2018 to September 2023. Emergency URS was defined as a procedure performed for acute ureteral obstruction due to symptomatic stones in patients presenting with: (1) severe ureteric colic unresponsive to conservative management; (2) acute renal impairment, indicated by a serum creatinine increase of ≥ 0.5 mg/dL or a calculated eGFR decrease of ≥ 15 mL/min within 24-48 hours; or (3) symptoms suggestive of urinary tract infection with systemic inflammatory response syndrome or suspected pyonephrosis requiring urgent intervention.

Ethical approval was obtained from the Ibb University ethics committee, following the principles of the Helsinki Declaration, with a waiver for individual patient consent due to the study's retrospective nature.

This investigation focused on emergency URS as a first-line treatment for ureteral stones that were refractory to conservative management or complicated by severe conditions. Additionally, patients with severe uremia or sepsis due to obstruction who underwent urinary decompression via percutaneous nephrostomy or ureteral stenting prior to definitive URS were included in the analysis.

Inclusion criteria

Participants included adult patients (aged 18 years and older) presenting with symptomatic ureteral calculi and subsequently undergoing emergency semirigid URS at our facility. All patients in the cohort presented with acute symptoms requiring emergent intervention, as defined above.

Exclusion criteria

Patients were excluded if they met any of the following criteria: (1) established ureteral strictures precluding safe URS access; (2) active UTIs (requiring initial treatment and exhibiting clinical signs of sepsis that were not directly related to the acute obstruction); (3) pregnancy; (4) severe orthopedic deformities that would have made proper positioning for URS impossible; (5) documented coagulation disorders that could not be medically corrected prior to intervention; or (6) those undergoing URS for non-emergency indications (e.g., elective stone removal, diagnostic ureteroscopy).

Patients with documented prior URS or other ureteral interventions were included as long as they met inclusion criteria.

Preoperative assessment

Comprehensive preoperative assessments were meticulously conducted to gauge the severity of the patients' acute presentation and guide treatment decisions. This included a detailed review of medical and surgical histories, including medication use (especially anticoagulants), prior urologic interventions, and comorbid conditions (diabetes, hypertension, cardiovascular disease). Clinical examinations focused on assessing vital signs (temperature, heart rate, blood pressure, respiratory rate) and signs of systemic illness, and thorough abdominal examinations. Investigations included: (1) renal function tests (blood urea nitrogen, creatinine); (2) complete blood count with differential; (3) urinalysis with microscopic examination to assess for the presence of hematuria, pyuria, and bacteriuria; and (4) urine culture and sensitivity if a UTI was suspected. Imaging evaluation comprised: (1) urinary tract ultrasound to assess for hydronephrosis, stone presence/location, and any evidence of renal abscess; (2) plain radiography (KUB) to assess for radiopaque stones; and (3) *non-contrast computed tomography* (NCCT) scans of the abdomen and pelvis to accurately characterize the stone, assess the degree of hydronephrosis, and evaluate for other potential etiologies. Stone characteristics, including dimensions (in mm), location (proximal, mid, or distal ureter), and *Hounsfield units* (HU) were evaluated using NCCT. The degree of hydronephrosis was graded based on the *Society of Urodynamics, Female Urology*, and Urogenital Reconstruction (SUFU) guidelines (mild, moderate, severe).

Surgical procedure

All TUL procedures were performed by experienced urologists with a minimum of 10 years of experience in endourology, including URS. The TUL procedure was performed under either general or regional anesthesia based on patient and surgeon preference and clinical assessment. A single intravenous dose of prophylactic antibiotics (Ceftriaxone) at a dose of one gram was administered before the induction of anesthesia and continued for 24-48 hours postoperatively, based on institutional protocols. Patients were positioned in the standard dorsal lithotomy position. The procedure commenced with rigid cystoscopy to visualize the bladder and identify the ureteral orifice. A hydrophilic guidewire was then advanced into the ureter under direct vision. A semirigid ureteroscope (*6-Fr, Karl Storz, Tuttlingen, Germany*) was employed, and stone fragmentation was accomplished using a *Swiss LithoClast® Pneumatic Lithotriptor*. Ureteroscopic procedures were performed by the experienced urologists. Retrieval of stone fragments was attempted with a retrieval basket or grasping forceps, especially for larger fragments. Smaller fragments (< 2 mm) were often left to pass spontaneously if it was deemed safe (absence of significant obstruction, no evidence of severe ureteral injury). *Double-J* (DJ) ureteral stents were placed at the discretion of the operating surgeon based on the clinical scenario, which was the presence of edema, anticipated difficulty with stone passage, or ureteral injury and were usually left in situ for 5-10 days unless complications arose. The reasons for stent placement were documented in the patient charts. For patients with significant hydronephrosis, impacted stones, solitary kidney, or those with pre-opera-

tive uremia, the DJ stent was retained for 4-6 weeks to facilitate optimal healing and prevent obstruction. Indwelling urethral catheters were not routinely inserted, except in cases where significant bleeding was expected, or for patients with comorbidities that required it. Operative time was recorded, defined as the time from insertion of the cystoscope to the completion of the procedure and removal of instruments. Fluoroscopy was used during the procedure.

Postoperative assessment

Postoperatively, patients received appropriate analgesics (non-steroidal anti-inflammatory drugs, opioids) and antiemetics as required. Alpha-blockers were administered as per clinical needs. Most patients were discharged within 24 hours, contingent on a stable clinical condition, absence of significant complications, and adequate pain control. Uremic patients were discharged only after laboratory and clinical parameters were normalized and after consultation with a nephrologist. Pain was assessed using a validated pain scale (e.g., visual analog scale). All patients were instructed to report any symptoms of fever, persistent pain, or changes in urinary function.

All patients underwent plain radiography (KUB) and abdominal ultrasound two days after surgery. Success was defined as the absence of residual stones larger than 2 mm, resolution of symptoms (colic), and improvement in renal function in patients presenting with renal impairment, or in the absence of complications. An additional ultrasound was conducted three months after the procedure. Stone clearance was confirmed by the absence of residual stones on radiological imaging, including radiography, ultrasound, or non-contrast CT scans within the first three months following URS. Follow-up imaging was based on clinical need and according to the established protocol.

Intraoperative complications were assessed using a modified version of the Satava classification system (10), specifically adapted for URS. Grade 1 complications were considered minor and did not negatively impact patient outcomes. This category included: (1) minimal mucosal injuries (observed only); (2) mild bleeding that was self-limited or easily controlled with irrigation; (3) instrument malfunctions that were easily and quickly resolved (e.g., guidewire issues, irrigation problems); and (4) proximal stone migration that could be managed with a change in technique or observation. Grade 2 complications necessitated some form of medical intervention. These were further subdivided into: Grade 2a, which included complications managed intraoperatively through endoscopic techniques (e.g., additional stone manipulation, repeat lithotripsy, stent placement due to ureteral injury), and Grade 2b, requiring subsequent endoscopic re-treatment within the same hospital admission. Examples included: (1) difficulties in accessing the ureter requiring use of alternative techniques (e.g., change of guidewire); (2) significant bleeding requiring prolonged irrigation, the use of hemostatic agents (e.g., topical thrombin); (3) extra-ureteral stone migration; (4) mucosal injuries such as false passages or thermal injuries (requiring stent placement); and (5) ureteral perforation requiring stent placement or other interventions, but without the need for open or laparoscopic surgery. Grade 3 complications were considered more severe and required open or laparoscopic surgical intervention. This category comprised: (1) severe bleeding requiring blood transfusion or surgical exploration; (2) persistent instrument malfunctions that prevented completion of the procedure; (3) inability to access the ureter or stone despite multiple attempts and the use of various techniques; (4) ureteral perforation with extravasation requiring open or laparoscopic repair; (5) ureteral intussusception; and (6) ureteral avulsion. Postoperative complications were systematically classified by the operating surgeon using the *Modified Clavien Classification System* (MCCS) (11). Each complication was evaluated according to the modified Clavien grading scale. In instances where patients experienced multiple complications, each was graded individually based on its severity.

Main outcomes

The primary outcome of this study was the prevalence of intraoperative and postoperative adverse events, while the secondary outcome aimed to identify factors associated with these complications.

Data collection

Data collected included: (1) patient demographics [age, gender, *body mass index* (BMI)]; (2) comorbidities (diabetes mellitus, hypertension, coronary artery disease, chronic kidney disease, etc.) were recorded using the Charlson Comorbidity Index; (3) previous treatments such as *extracorporeal shock wave lithotripsy* (ESWL) and other prior interventions for ureteral stones; (4) radiological characteristics of stones [*Hounsfield units* (HUs), size (in mm), location (proximal, mid, distal ureter), number of stones, laterality (left/right), and degree of hydronephrosis (SUFU grading)]; (5) presenting symptoms (colic, infection, renal insufficiency), including the duration of symptoms before the presentation; (6) treatment outcomes; (7) intraoperative and postoperative complications (classified as described above); and (8) *stone-free rates* (SFR) at 2 days and 3 months. The S.T.O.N.E. scoring system was calculated based on preoperative non-contrast CT findings, incorporating Size, Topography, Obstruction, Number, and Evaluation of *Hounsfield units* (HU) (12). Data was extracted from electronic medical records and from the patient's medical chart.

Statistical analysis

Statistical analyses were conducted using SPSS version 22 (*IBM, Armonk, NY*). Continuous variables are presented as means ± standard deviations or medians with *interquartile ranges* (IQR) and compared using the Student's t-test for normally distributed data and the Mann-Whitney U-test for non-normally distributed data. Categorical variables are reported as frequencies and percentages and analyzed using Pearson's chi-square test or Fisher's exact test, where appropriate. Univariate analysis was performed to identify potential risk factors associated with intraoperative and postoperative complications. Variables with a p-value < 0.2 in univariate analysis were then considered for inclusion in a multivariate logistic regression model to identify independent predic-

tors of complications. The multivariate model included variables that were clinically relevant to the outcome. Results were reported as *adjusted odds ratios* (AORs) with 95% *confidence intervals* (CIs). A p-value < 0.05 was considered statistically significant.

Results

This study included a total of 266 patients, with a mean age of 47.7 ± 15 years and a median age of 44 years (range: 18 to 91 years). The cohort was predominantly male, comprising 192 individuals (72.2%). The mean weight of the patients was 72.7 ± 9.8 kg, with a median of 72 kg (range: 46 to 110 kg). The most common presenting symptom was acute flank pain, reported by 168 patients (63.2%), followed by fever in 60 patients (22.6%) and hematuria in 38 patients (14.3%). The majority of stones were located on the right side (n = 141, 53.0%), and a history of prior ESWL was noted in 31 patients (11.7%). Comorbid conditions included diabetes in 13 patients (4.9%) and hypertension in 10 patients (3.8%) (Table 1).

Preoperative CT scans indicated a mean stone size of 9.1 ± 4.9 mm and a median size of 8 mm (range: 4 to 24 mm). Multiple stones were identified in 132 patients (52.0%), with an average of 1.6 ± 0.6 stones per patient and a median of 2 stones (range: 1 to 3). The mean stone density was measured at 523.4 ± 281.4 HU, with a median of 458.5 HU (range: 0 to 1351 HU). Hydronephrosis severity was classified as mild in 188 patients (74.0%), moderate in 52 patients (20.5%), and severe in 14 patients (5.5%).

The majority of ureteral stones were located in the mid-ureter (n = 181, 71.3%), while distal and proximal ureteral stones were present in 68 patients (26.8%) and 5 patients (2.0%), respectively. All patients underwent urgent ureteroscopy utilizing semirigid ureteroscopes; however, the procedure was unsuccessful in 7 patients (2.63%), resulting in the placement of a double J stent, with successful completion of the procedure one week later. The mean operative time was 57.7 ± 7.3 minutes, with a median of 55 minutes (range: 45 to 77 minutes) (Table 2).

Variable [a]	Subgroup	Total (266)	Complications		OR (95% CI)	p-value [b]
			no (239)	Yes (27)		
Age (year)	Mean ± SD	47.7 ± 15.0	47.4 ± 15.0	50.0 ± 15.2	1.01 (0.99-1.04)	0.386
Gender	Male	192 (72.2)	170 (71.1)	22 (81.5)	Ref	0.362
	Female	74 (27.8)	69 (28.9)	5 (18.5)	0.56 (0.18-1.43)	
Weight (kg)	Mean ± SD	72.7 ± 9.8	72.9 ± 9.6	71.0 ± 10.9	0.98 (0.94-1.02)	0.343
History of diabetes	No	253 (95.1)	230 (96.2)	23 (85.2)	Ref	0.040
	Yes	13 (4.9)	9 (3.8)	4 (14.8)	4.44 (1.13-14.85)	
History of hypertension	No	256 (96.2)	230 (96.2)	26 (96.3)	Ref	1.000
	Yes	10 (3.8)	9 (3.8)	1 (3.7)	0.98 (0.05-5.54)	
History of previous ESWL	No	235 (88.3)	213 (89.1)	22 (81.5)	Ref	0.392
	Yes	31 (11.7)	26 (10.9)	5 (18.5)	1.86 (0.59-5.01)	
Symptoms at Presentation	Acute flank pain	168 (63.2)	151 (63.2)	17 (63.0)	Ref	
	Hematuria	38 (14.3)	36 (15.1)	2 (7.4)	0.49 (0.08-1.83)	0.359
	Fever	60 (22.6)	52 (21.8)	8 (29.6)	1.37 (0.53-3.27)	0.495

SD: standard deviation; ESWL: Extracorporeal shock wave lithotripsy; OR: odds ratio, CI: confidence interval.
[a] Data were presented as count (percentage) or mean (standard deviation).
[b] P-Valus of < .05 were blooded and considered statistically significant and analyzed by Student's- t-test and chi-square test.

Table 1.
Patients demographic characteristics.

Variable [a]	Subgroup	Total (266)	Complications		OR (95% CI)	p-value [b]
			no (239)	Yes (27)		
Stone size (mm)	Mean ± SD	9.1 ± 4.9	8.4 ± 4.4	15.5 ± 5.1	1.31 (1.20-1.44)	< 0.001
Stone density (HU)	Mean ± SD	523.4 ± 281.4	517.4 ± 286.7	577.0 ± 226.6	1.00 (1.00-1.00)	0.297
Hydronephrosis degree	Mild	195 (73.3)	177 (74.1)	18 (66.7)	Ref	0.712
	Moderate	55 (20.7)	48 (20.1)	7 (25.9)	1.43 (0.53-3.50)	0.447
	Severe	16 (6.0)	14 (5.9)	2 (7.4)	1.40 (0.21-5.58)	0.669
Stone location	Distal	70 (26.3)	68 (28.5)	2 (7.4)	Ref	
	Middle	188 (70.7)	169 (70.7)	19 (70.4)	3.82 (1.07-24.40)	0.077
	Proximal	8 (3.0)	2 (0.8)	6 (22.2)	102.00 (14.77-1188.43)	< 0.001
Operative time (min)	Mean ± SD	55.7 ± 8.9	55.9 ± 9.0	53.6 ± 8.5	0.97 (0.92-1.02)	0.208
S.T.O.N.E. Score	Mean ± SD	8.0 ± 1.8	7.8 ± 1.7	10.0 ± 1.2	2.43 (1.77-3.55)	< 0.001
Stone number	Single	122 (45.9)	120 (50.2)	2 (7.4)	Ref	< 0.001
	Multiple	144 (54.1)	119 (49.8)	25 (92.6)	12.61 (3.65-79.44)	

HU: Hounsfield Units; SD: standard deviation; OR: Odds ratio, CI: confidence interval.
[a] Data were presented as count (percentage) or mean (standard deviation).
[b] P-Valus of < .05 were blooded and considered statistically significant and analyzed by Student's- t-test and chi-square test.

Table 2.
Radiologic and operative characteristics.

The overall complication rate was 10.2%. Intraoperative complications were observed in 16 patients (6.0%), primarily consisting of mucosal damage (n = 9, 3.4%), stone up-migration or retropulsion (n = 8, 3.0%), and ureteral perforation (n = 1, 0.4%). Postoperative complications occurred in 13 patients (4.9%), with fever being the most prevalent (n = 7, 2.6%), followed by hematuria in 3 patients (1.1%). Additional complications included febrile urinary tract infection, pyelonephritis, and one case of mortality (n = 1, 0.4%). Importantly, there were no significant intraoperative complications, such as ureteral avulsion. Among the postoperative complications, two notable cases emerged: one patient developed pyelonephritis and was treated with intravenous antibiotics, while another patient succumbed to diabetic ketoacidosis compounded by emphysematous pyelonephritis, sepsis, and multiorgan failure. The overall SFR at follow-up was 85.3%, as verified by postoperative radiographic examinations; however, 39 patients (14.7%) exhibited residual stones and required additional endourological interventions (Table 3).

Factors associated with complications

Univariate analysis identified several factors significantly associated with complications, including a history of diabetes (p = 0.040), larger stone size (p < 0.001), presence of multiple stones (p < 0.001), S.T.O.N.E. score (p < 0.001), and stones located in the proximal ureter (p < 0.001).

In multivariate analysis, the key predictive factors for complications included large stone size AOR: 1.3; 95% *Confidence Interval* (CI): 1.15-1.39, p < 0.0001) and the proximal ureter location of stones (AOR: 4.9; 95% CI: 1.31-18.23, p = 0.0182) (Table 4).

Table 3.
Intraoperative and postoperative complications characteristics.

Complication *	N (%)
Intraoperative	16 (6.0%)
Mucosal damage	9 (3.4%)
Stone up-migration or retropulsion	8 (3.0%)
Ureteral perforations	1 (0.4%)
Postoperative	13 (4.9%)
Fever (Grade I)	7 (2.6%)
Hematuria (Grade I)	3 (1.1%)
Febrile UTI (Grade II)	1 (0.4%)
Pyelonephritis (Grade III)	1 (0.4%)
Death (Grade V)	1 (0.4%)

UTI: Urinary tract infection.
** Some patients had multiple complication.*

Discussion

URS has seen significant advancements, establishing itself as a safer and more effective approach for the management of urinary tract stones. Innovations in smaller ureteroscopes and the development of advanced instruments and energy sources have improved procedural outcomes; however, complications remain a concern, emphasizing the need to identify predictive factors associated with these risks (4, 5).

This study examines the complications and outcomes associated with emergency semirigid URS in managing ureteral calculi within a resource-limited setting. Our findings show that semirigid URS yields excellent outcomes, exhibiting high stone clearance rates and minimal complications, with larger stone sizes and proximal stone locations identified as significant predictors of adverse events.

The variability in intraoperative complication rates among studies can be attributed to several factors, including differences in study design, patient demographics, stone characteristics, surgical techniques, and the expertise of the surgical teams. Our investigation revealed an overall intraoperative complication rate of 6.0%, comprising mucosal damage (3.4%), stone upward migration (3.0%), and ureteral perforations (0.4%). For comparison, *Geavlete et al.* reported an intraoperative complication rate of 3.6% in a cohort of 98 cases, highlighting mucosal injuries and stone migrations (13). *Tanriverdi et al.* documented a higher complication rate of 8%, which included transient hematuria, mucosal erosion, and ureteral perforations (4). The lower complication rate observed in our study may reflect the experience of the surgical team, as more complex cases are frequently

Variable [a]	Subgroup	No (239)	Yes (27)	Cured OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value [b]
History of diabetes	No	230 (90.9)	23 (9.1)	Ref	0.235	-	-
	Yes	9 (69.2)	4 (30.8)	2.80 (0.46-14.61)		-	-
Stone size (mm)	Mean ± SD	8.4 ± 4.4	15.5 ± 5.1	1.18 (1.05-1.35)	0.007	1.3 (1.15-1.39)	< 0.0001
Stone number	Single	120 (98.4)	2 (1.6)	Ref	0.918	-	-
	Multiple	119 (82.6)	25 (17.4)	1.12 (0.15-11.70)		-	-
Stone location	Distal	68 (97.1)	2 (2.9)	Ref		-	-
	Mid	169 (89.9)	19 (10.1)	1.03 (0.23-7.18)	0.973	-	-
	Proximal	2 (25.0)	6 (75.0)	10.97 (1.18-150.52)	0.046	4.9 (1.31-18.23)	0.0182
S.T.O.N.E. Score	Mean ± SD	7.8 ± 1.7	10.0 ± 1.2	1.54 (0.90-2.65)	0.113	-	-

SD: standard deviation; CI: confidence interval; OR: Odds ratio.
[a] Data were presented as count (percentage) or mean (standard deviation).
[b] P-Valus of < .05 were blooded and considered statistically significant and analyzed by Multivariate regression analysis test.

Table 4.
Predictive factors for complications in Multivariate regression analysis.

referred to the capital city, where a specialized urology team with advanced equipment operates.

Among intraoperative complications, ureteral mucosal injury was the most commonly reported, consistent with findings from previous studies (4, 14). Such injuries often occur during the introduction of operative instruments, including the ureteroscope and guide wires. Importantly, all complications were managed conservatively, avoiding the need for open surgery and resulting in favorable outcomes.

The upward migration of stones, observed in 3.0% of cases, is often linked to larger stones during URS, particularly when using pneumatic lithotripsy. Proximal ureteric stones exhibit migration rates approaching 30%, underscoring the importance of anti-retropulsion devices (4, 14). The advent of devices like the Stone Cone and various entrapment nets aims to mitigate the risk of stone migration during ureteroscopic procedures (8).

Importantly, our study noted a low incidence of ureteral perforations at 0.4%. These perforations typically arise due to excessive force during the advancement of the ureteroscope. The incorporation of smaller-caliber ureteroscopes can facilitate safer navigation through narrowed regions of the ureter (9, 15). Predicting complications, particularly in urgent cases, necessitates consideration of potential anatomical variations, such as constricted ureteric lumens, prevalent in a significant percentage of patients undergoing urological procedures (15, 16).

Postoperative complication rates are notably variable in the literature. Recent reviews, including a study by *De Coninck et al.*, reported that postoperative febrile events and *urinary tract infections* (UTIs) can vary from 0.2% to 15%, with renal colic rates ranging from 1.1% to 10.2%. In our cohort, the overall postoperative complication rate was 4.9%. Fever was the most common complication (2.6%), followed by hematuria (1.1%), with isolated cases of febrile UTI, pyelonephritis, and mortality (0.4%). These results resonate with findings from *Perez et al.*, who similarly identified fever as the predominant postoperative complication (17). Despite these occurrences, we did not document any severe postoperative complications aside from one case of urosepsis requiring hospitalization and another involving a patient with diabetes who succumbed to multiorgan failure. The risk of severe outcomes, particularly those associated with urosepsis, remains a critical concern, reinforcing the necessity for adherence to safety protocols and effective management strategies during interventions (3). Overall, practical experience, judicious patient selection, thorough preoperative assessment, and close follow-up for high-risk patients likely contribute to the low incidence of complications observed in our study.

Our findings reported an overall *stone-free rate* (SFR) of 85.3% post-URS, consistent with results from other studies, including *Alameddine et al.* (89.0%), *Shrestha et al.* (80.5%), *Kim et al.* (85.7%), and *Sirirak et al.* (89.68%) (18-21). Conversely, a study conducted in Ethiopia revealed a notably lower SFR of 54.7%, attributed to limited experience among surgical staff and less advanced equipment (22). The inconsistency in the definition of SFR across studies raises questions about the comparability of reported outcomes, as divergent imaging techniques can yield varied results.

The report identifies a mean patient age of 47.7 ± 15 years, with a male predominance, reflecting trends observed in other geographic regions such as Ethiopia, Iraq, and Egypt (22-25). Notably, our analysis revealed no significant correlation between age and complication rates, aligning with observations from *Mustafa et al.* (26). While some studies suggest an increased risk of complications with advancing age (27, 28), our findings indicate that age alone may not serve as a critical determinant of adverse outcomes.

Regarding gender, we found no statistically significant correlation with complications in our study, although previous research suggests gender may influence stone clearance rates and complication risks (7, 29). Comorbid conditions, particularly diabetes mellitus, were identified as contributing factors to postoperative complications. This aligns with historical data suggesting that diabetes increases the risk of adverse outcomes following URS (3, 30, 31). However, the small sample size limits our ability to draw definitive conclusions regarding these associations.

Moreover, our findings support the notion that stone characteristics – such as size, location, and density – serve as predictors of complications. Larger stone size and proximal location were shown to be significant predictors in our multivariate analysis, corroborating previous literature (22, 24, 32, 33). The rationale for this association is that larger stones necessitate longer operative times and greater irrigation volumes, increasing the likelihood of complications. Interestingly, we found no statistical correlation between stone density and complications, potentially due to the limited sample size available for analysis. While the American Urological Association recommends flexible URS for larger upper ureteric calculi, evidence suggests that semirigid URS can effectively treat upper ureteric stones, including larger and impacted stones (24, 34). Our study reinforced the importance of considering stone location as a predictive factor for complications – echoing findings from prior studies (22, 25).

The presence of multiple stones was also evaluated; while we observed some association, it was statistically significant only in univariate analyses. In line with our findings, *Mustafa et al.* did not find a correlation between stone number and complications (26). Other reports indicate the number of stones is an independent predictor of low stone clearance, higher retreatment rates, and longer operative times, although they did not report an increase in complications (35, 36). Conversely, *Perez et al.* noted that having multiple stone locations was linked to higher postoperative complications (17). Additional factors potentially impacting URS complications may include the surgeon's experience, the use of auxiliary equipment, and different lithotripsy devices; however, these factors were not analyzed in our study due to the absence of laser lithotripters and the decision to avoid basket retrieval methods during most ureteroscopic procedures.

Study limitations

This study has several notable limitations. The primary constraints include a low sample size and a retrospective design, which may affect the robustness of our findings. Relying on secondary data introduces variability in data

quality, potentially due to inconsistencies in documentation practices. The retrospective nature may also introduce selection and recall biases that could influence outcomes; the limited sample size restricts the ability to perform comprehensive statistical analyses. Additionally, all procedures were conducted by experienced urologists, which might skew results toward more favorable outcomes.

The presence of ureteral stents may impede the detection of minor stone fragments after removal, potentially contributing to increased postoperative complications. However, this study is the first systematic evaluation of complications associated with semirigid ureteroscopy in patients with ureteral stones at our center, yet its findings should be interpreted with caution. The single-center nature of this research limits the generalizability of the results to other populations and settings. Future research with larger sample sizes and multicenter designs is essential to enhance understanding of the unique challenges and opportunities for treatment in resource-limited environments.

Conclusions

Emergency ureteroscopy with a semirigid ureteroscope has shown promising outcomes in managing ureteral stones. This approach is associated with minimal intraoperative and postoperative complications, as well as satisfactory stone-free rates. Key factors in optimizing these outcomes include careful instrument selection, the surgical team's expertise, and adherence to meticulous surgical techniques. Attention to these details is especially critical in complex cases involving larger stones or those positioned in the proximal ureter, where procedural challenges may increase. Prioritizing these aspects can significantly reduce the risks of adverse events during emergency ureteroscopy.

Declarations

Ethical approval:

Availability of data and material: *All the data was included in this study.*

Competing interests: *The author declares no potential conflict of interest.*

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