Outcomes of ureteroscopy in Assiut University Hospital: a prospective study

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Context
Recent technological advances have led to the expansion of indications and success of ureteroscopy (URS) for stone disease, while decreasing complication rates.

Aims
The aim was to evaluate the outcomes of URS for treatment of ureteral stones in our hospital.

Settings and design
This was a descriptive case series.

Materials and methods
Patients included were adults with ureteral stone(s) managed by URS. Perioperative together with long-term postoperative data were analyzed. Follow-up extended for 12 months.

Statistical analysis
Data analysis was done using SPSS version 19. χ^2 and Fisher exact tests were used to compare between qualitative variables. Mann–Whitney test was used to compare between two quantitative variables. Multiple logistic regression analysis was done to measure the risk factors. *P* value was considered statistically significant when less than 0.05.

Results
During the period from May 2015 to August 2016, 251 adult patients underwent 263 ureteroscopies for treatment of 304 ureteral stones. The mean total stone burden was 12.8 ± 5.9 mm. Treatment of bilateral and ipsilateral multiple stones was performed in 12 and 34 cases, respectively. Impacted stone(s) were treated in 49 (18.6%) procedures. The mean operative time was 54.8 ± 22.68 min. Initial and final stone-free rates were 83.3 and 100%, respectively. The overall complications rate was 28.1%, including mucosal injury (*n* = 20, 7.6%), false passage (*n* = 25, 9.1%), perforation (*n* = 7, 3.8%), and stricture (*n* = 4, 1.5%). Multivariable analysis revealed that impacted stones had a significant association with intraoperative complications.

Conclusion
URS is a safe and effective procedure for treatment of ureteral stones. However, impacted stones are associated with significantly higher complications rate.

Keywords:
complications, outcomes, ureteral stones, ureteroscopy

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Introduction

Recent improvements in endoscopes and stone disintegration devices together with increasing physicians' experience have expanded indications and success of ureteroscopy (URS) for stone disease, while decreasing complication rates [1–4].

Unlike other alternatives, such as shock wave lithotripsy (SWL), antegrade URS, and laparoscopic ureterolithotomy, URS has the unique advantage of safety in pregnant patients and patients with bleeding diathesis [5–11]. Moreover, URS is more effective than SWL in cases of lower ureteral stones and morbid obesity [12–15].

This study aims to prospectively assess the outcomes of URS for treatment of ureteral stones in large number of patients and for long-term follow-up period.

Materials and methods

This was a prospective case series. A total of 251 patients were selected as the sample population from among patients attending at Urology outpatient clinic at Urology and Nephrology Hospital at Assiut University during the period from May 2015 to August 2016.

Included patients were surgically fit adults with ureteral stone(s) who underwent transurethral URS, regardless of the stone(s) location, number, side, laterality, or radiopacity. Authors obtained permission from the local

ethics committee before conducting this study, together with written informed consents from all patients. Patients with ipsilateral renal stone(s) were excluded.

History taking, clinical examination, pelviabdominal ultrasound, plain kidney-ureter-bladder (KUB), noncontrast computed tomography – urinary tract, urine analysis, routine preoperative laboratory investigations, and surgical fitness were done for all cases. Urine culture was done in case of pyuria, and urinary tract infection was treated preoperatively with antibiotics selected according to sensitivity pattern.

The mean total stone burden was calculated in cases of multiple ipsilateral stones by summing the maximal diameters of the stones. Stone location was defined according to plain KUB as follows: (a) upper ureteral stones: those located above the upper border of sacroiliac joint, (b) lower ureteral stones: those located below the lower border of sacroiliac joint, and (c) middle ureteral stones: those located between the upper and lower borders of sacroiliac joint.

Stones were considered impacted when they were present at the same site for more than 2 months, caused moderate or severe hydronephrosis (HN) by preoperative U/S, caused obstructive anuria, and/or diagnosed intraoperatively as impacted stones (i.e. difficulty encountered in passing a standard guidewire beyond the level of the stone at the first trial) [16–18].

Under spinal or general anesthesia, once the ureteral orifice was identified by cystoscope, retrograde ureterography was done to delineate the upper urinary tract; subsequently, a guidewire was passed beyond the stone. If the routine polytetrafluoroethylene-coated, straight-tipped guidewire (Accoat; SP Medical, Karise, Denmark) with 0.035-inch diameter and 150-cm length failed to pass, then the nitinol Zebra, the Zipwire, or the Sensor guidewires (Boston Scientific, Natick, Massachusetts, USA (were introduced instead.

Semirigid Richard Wolf ureteroscopes with tip diameters of 6 or 8 Fr and lengths of 31.5 or 43 cm were used. If the ureter did not permit small ureteroscope, it was dilated by either Teflon or balloon dilators, then the ureteroscope was introduced into the ureter till reaching the stone. A ureteral stent was inserted before re-do URS if active dilatation could not be achieved. These failed trials of URS were not counted among total procedures as they lacked most of the steps of URS.

After reaching the stone by ureteroscope, the stone was either extracted by Dormia basket or disintegrated by either the pneumatic (PL) or laser lithotripters (LL). In case of failure of stone disintegration by PL, then LL was used instead. Stone fragments were extracted by Dormia basket if required.

At the end of procedure, the ureter was inspected endoscopically to detect and deal with any residual stone fragments or ureteral injury. This was followed by etrograde Pyelography (RPG) to detect any extravasation.

Ureteral stenting was done according to the situation. Finally, fluoroscopic confirmation of correct stent position and stone clearance was done and then a urethral catheter was inserted. The term 'immediate clearance' was used when the final fluoroscopic shot showed that the ipsilateral ureterorenal unit was either completely cleared of stones or had only insignificant residual fragments (≤3 mm in size).

The term mucosal abrasion was used to describe the small superficial mucosal tears that are not extending beyond mucosa. Ureteral perforation was diagnosed by the presence of visible periureteral fatty tissue and/or contrast extravasation. The term false passage was used when an instrument perforates the mucosa, without penetrating the whole ureteral wall [19].

Secondary ureteroscopies were in the form of either re-do URS owing to failed access or second-look URS owing to large residual stones.

Plain KUB was done the day next to the procedure. Intravenous third-generation cephalosporins were administrated during the postoperative inpatient period.

Follow-up ultrasound and clinical assessment were done after stent removal through four separate visits every 3 months, with the first visit including urine analysis±culture.

If the ultrasound showed backpressure, CT-urography (CTU) was done to show the cause and level of obstruction. Consequently, diuretic renogram was done to confirm the presence or absence of obstruction.

Date entry was done using Microsoft Excel 2015 and 2016 versions, whereas data analysis was done using SPSS version 19 (statistical package for the social sciences; SPSS Inc., Chicago, Illinois, USA). Data were presented as frequency, percentage, mean, SD, and median. χ^2 and Fisher exact tests were used to compare between qualitative variables. Mann–Whitney test was used to compare between two quantitative variables in case of nonparametric data. Multiple logistic regression analysis was done to measure the risk factors. *P* value was considered statistically significant when less than 0.05.

Results

A total of 263 ureteroscopies were performed for management of 251 patients (183 males and 68 females) with 304 ureteral stones. The mean ± SD age was 43.45 ± 13.57 years. The mean ± SD BMI was 28.39 ± 3.96. The mean ± SD total stone burden was 12.8 ± 5.9 mm. Bilateral URS was done in 12 cases. URS for multiple ipsilateral ureteral stones was done in 34 (12.9%) procedures. URS for treatment of impacted stones was done in 49 (18.6%) procedures.

The mean ± SD operative time was 54.77 ± 22.68 min. The mean stent duration was 42.4 days for total stented procedures, 68.5 days for JJ-stented procedures, and 3.3 days for ureteral catheter – stented procedures. Tables 1–3 illustrate the preoperative and intraoperative data of the cases.

Initial and final stone-free rates (SFR) were 83.3 and 100%, respectively. Bivariate analysis of preoperative and intraoperative variables with SFR revealed that significantly lower SFR were found in each of the following situations: (a) upper stone location, (b) large stone burden, (c) when Dormia basket was not utilized, (d) when lithotripsy was not performed, (e) JJ stent insertion, and (f) longer stent duration.

The overall complications rate was 28.1%. A total of 104 complications (71 intraoperative, 29 early postoperative, and four strictures) were encountered in 74 procedures. Intraoperative complications occurred in 61/263 (23.2%) procedures (in nine procedures, there were more than one complication). Neither open conversion nor termination of procedure due to intraoperative complications took place in any procedure (Table 4).

Bivariate analysis showed that significantly higher incidence of intraoperative complications was found in each of the following situations: (a) right-sided stone(s), (b) larger stone burden, (c) impacted stone(s), (d) longer operative time, (e) JJ stent insertion, and (f) longer stent duration.

Multivariable analysis using logistic regression test revealed that only impacted stones and longer duration of stent had significant association with intraoperative complications (Table 5). Stricture occurred after 4/263 (1.5%) procedures.

Table 1 Preoperative patient characteristics

	n (%)
Sex	
Male	183 (72.9)
Female	68 (27.1)
Age (years)	
<30	47 (18.7)
30-40	57 (22.7)
40-50	53 (21.1)
≥50	94 (37.5)
BMI	
Normal	44 (17.5)
Overweight	123 (49.0)
Obese	84 (33.5)
Main presentation	
Loin pain	183 (72.9)
LUTS	12 (4.8)
Oliguria	27 (10.8)
Hematuria	4 (1.6)
Fever/UTI	16 (6.4)
asymptomatic	9 (3.6)
Medical comorbidities	
Free	185 (73.7)
DM	25 (10)
HTN	23 (9.2)
CRI	6 (2.4)
Morbid obesity	1 (0.4)
IHD	5 (2)
Mixed	6 (2.4)
Laterality	
Unilateral	239 (95.2)
Bilateral	12 (4.8)
Serum creatinine at time of procedure	
Raised	21 (8.4)
Normal	230 (91.6)

n=251. CRI, chronic renal impairment; DM, diabetes mellitus; HTN, hypertension; IHD, ischemic heart disease; LUTS, lower urinary tract symptoms; UTI, urinary tract infection.

Discussion

Major advances have been applied to URS over the past two decades resulting in expansion of the indications of URS, higher success rate, and lower complication rate. Miniaturization of ureteroscopes; introduction of flexible URS and laser technology; invention of new, less traumatic accessories such as nitinol stone baskets and hydrophilic guidewires, and improvements of the visualization equipment are some examples [1–4].

Despite all these technical advances and the increased worldwide physicians' experience, complications and unfavorable intraoperative incidents still occur, which may lead to severe and long-term morbidities. This rises the importance of anticipating and therefore prevention of URS complications. On reviewing the literature over the past 10 years, the overall complication rates ranged from 3 to 38% [1,18,20–31].

In our study, intraoperative complications occurred in 61/263 (23.2%) procedures, including mucosal abrasions, intraoperative hematuria, perforation, and false passage. The most common intraoperative complication was submucosal false passage with an incidence of 9.1% (24 procedures). It was caused by

Table 2 Preoperative stone and urinary tract characteristics

	n (%)*
Previous ipsilateral stone intervention/stone pass	
None (primary stone disease)	171 (65)
SWL	33 (12.5)
URS	23 (8.7)
Trial URS - failed	2 (0.8)
Open ureteral surgery	47 (17.9)
Prestenting	
Not prestented	226 (90.5)
Prestented	25 (9.5)
Stone number	
Single stone	229 (87.1)
Multiple ipsilateral stones**	34 (12.9)
Side	
Right	134 (51)
Left	129 (49)
Total stone burden	
5-10 mm	100 (38)
10-15 mm	89 (33.8)
15-25 mm	59 (22.4)
25-35 mm	15 (5.7)
Radiopacity	
Radiopaque	210 (79.8)
Radiolucent	53 (20.2)
Stone location	
Upper	68 (25.9)
Middle	51 (19.4)
Lower	131 (49.8)
Multiple levels	13 (4.9)

SWL, shock wave lithotripsy; URS, ureteroscopy. *n=263.
**27 cases had two stones and seven cases had three stones.

Table 3 Intraoperative variables

	n (%)
Ureteroscope diameter	
8.5-11.5 Fr	200 (76)
6-7.5 Fr	63 (24)
Active ureteral dilatation	
None	29 (11)
Balloon	72 (27.4)
Teflon	162 (61.6)
≥10 Fr	17 (6.5)
≥12 Fr	80 (30.4)
≥14 Fr	65 (24.7)
Stone management	
Lithotripsy	212 (80.6)
PL	116 (44.1)
LL	77 (29.3)
PL + LL	19 (7.2)
Extraction of unfragmented stones	38 (14.4)
Migration of stone	13 (4.9)
Ureteral stenting	
Stentless	10 (3.8)
Double-J stent	152 (57.8)
Ureteric catheter	101 (38.4)

n=263. LL, laser lithotripsy; PL, pneumatic lithotripsy.

either the guidewire or Dormia basket. Twenty-one procedures required JJ stenting, whereas ureteral catheter was inserted in two procedures, and in the remaining procedure, the ureter was left non-stented. None of the procedures showed HN on serial follow-up U/S for 12-month duration. Similar to our study, false passage was the most common complication in a study by Elashry *et al.* [1] and was the second most common study after mucosal abrasion in another study by Geavlete *et al.* [32]. The incidence of false passage in recently published studies was 0.6–1.7% [1,8,32].

Table 4 Complications and unfavorable incidents

	n (%)
Intraoperative complications[a]	
Mucosal injury	20 (7.6)
Bleeding	17 (6.5)
Perforation	7 (3.8)
False passage	24 (9.1)
Total procedures with intraoperative complications	61 (23.2)
Unfavorable incidents	
Accidental Stone migration	40 (15.2)
Residual ureteral stones	7 (2.7)
Early postoperative complications	
Fever	10 (3.8)
UTI requiring shift of antibiotic	8 (3)
Pain/colic	4 (1.5)
Hematuria	7 (2.7)
Total procedures with early postoperative complications	29 (11)
Late postoperative complications	
Stricture	4 (1.5)

n=263. UTI, urinary tract infection. [a]In nine procedures, there were more than one intraoperative complication.

Table 5 Multiple logistic regression of intraoperative complications

	P	OR	95% CI	
			Lower	Upper
Side (right)	0.058	0.530	0.274	1.022
Total stone burden	0.387	1.024	0.971	1.079
Impacted stone	<0.001*	5.552	2.744	11.232
Operative time (min)	0.374	1.006	0.992	1.021
Stent duration (days)	0.007*	1.011	1.003	1.020

CI, confidence interval; OR, odds ratio. *P<0.05, significant.

The second common complication in our study was mucosal injury with an incidence of 7.6% (20 procedures). Its incidence in recently published studies ranged from 1.1 to 9.5% [1,8,18,25,28–30,32].

Intraoperative hematuria occured in 17 (6.5%) procedures. It did not change the course of the procedure in any case. In literature, the incidence of intraoperative hematuria ranged from 0.1 to 4.2% [1,18,23,26,28,29,32].

Ureteral perforation in our study occurred in seven procedures (3.8%). All these procedures were stented by JJ at the end of procedure. None of them showed HN on serial U/S follow-up after stent removal. The

incidence of perforation in recent studies ranged from 0.4 to 6.7% [1,17,18,20–24,26–30,33].

Bivariate analysis of our results revealed that impacted stones, right-sided stones, large stone burdens, longer operative time, JJ insertion, and longer stent duration were significantly associated with higher rates of intraoperative complications. However, logistic regression test revealed that only impacted stones and longer duration of stent had significant association with intraoperative complications.

Similar to our results, Tanriverdi *et al.* [18] found that impacted stones were significantly associated with more incidence of intraoperative complications. Moreover, El-Qadhi [29] noted six cases of perforation in a total of 147 (4.1%) cases, and all of them had impacted stones.

Our results revealed that longer operative time was significantly associated with more incidence of intraoperative complications by using bivariate analysis. Similarly, Schuster *et al.* [34] noted a significant association of ureteral perforation with increased operative time.

None of the intraoperative complications in our study necessitated termination of the procedure or open conversion. Similarly, most of the recent studies reported very low (0–0.7%) incidence of open conversion owing to intraoperative complications [1,18,20,23,27,29,32,33,35–40]. Regarding procedure termination owing to intraoperative complications, the incidence in literature is up to 3.5%, which is slightly higher than ours [1,29,32,33,35–41].

Regarding unfavorable incidents, the incidence of stone migration in literature ranged from 0.4 to 9%, with the upper stone location, stone impaction, and the severity of HN representing the main risk factors [1,20,23,25,26,28,30,42]. In our study, the incidence of accidental stone upward migration was 15.2% (40 procedures).

In our series, the initial SFR was 83.3% (219 out of 263 procedures) which falls within the same range as in literature (0.8–95.3%). Following auxiliary procedures in 39 procedures and medical treatment in four, the final SFR has reached 100% which is higher than the range in most studies (82.2–99.4%) [1,8,18,20,24,25,27,29,30,37,38,42].

SFR is affected by multiple factors as stone location, impaction, stone burden, method of lithotripsy, and type of ureteroscope. In the current study, the type of lithotripsy had no statistically significant relation to SFR. The same result was obtained by Mursi *et al.* [25]. Contrarily, several authors reported significantly higher SFR when using LL in comparison with PL [35,36,39–41,43,44].

Karadag *et al.* [45], by using flexible URS, achieved significantly better outcomes than semirigid URS. In our study, all procedures were performed by using semirigid URS; therefore, the outcomes of flexible URS were not assessed.

Our results revealed that stone impaction had no statistically significant relation to SFR. This is contradictory to a study by Legemate *et al.* [46] who found that impacted stones were associated with significantly lower overall SFR than nonimpacted stones (87.1 vs. 92.7%, $P < 0.001$).

Treatment of lower ureteral stones yielded significantly higher SFR than upper ureteral stones in the current study (90.7 vs. 69.2%, $P < 0.001$), a finding which echoed several studies [20,25,27]. For example, Khoder *et al.* [47], by using LL, found significantly higher SFR after single procedure for stones in distal ureter (37/37, 100%) when compared with those in proximal ureter (42/51, 82.4%). Following second treatment, SFR for proximal stones raised to 94.1% but was still lower than that of distal stones. Similarly, Gunlusoy *et al.* [48] reported a SFR of 96.2% in a study of 1296 patients by using ureteroscopic PL. Success rate for upper, middle, and lower ureteral stones was 90.5, 93.1, and 98.1%, respectively ($P < 0.05$).

Larger stone burdens were significantly associated with lower SFR in our study. This finding is supported by several studies; for example, Gunlusoy *et al.* [48] found that SFR for calculi less than or equal to 10 mm was 97.6% whereas SFR for those greater than 10 mm in size was 91.2% ($P < 0.05$).

Bivariate analysis of our results showed that, in addition to large stone burden and upper stone location, SFR was significantly lower in the following situations: (a) when Dormia Basket was not used, (b) when lithotripsy was not performed, (c) insertion of JJ stent, and (d) longer stent duration. This may be explained by an early stone migration which had occurred in these situations, leading to JJ stent insertion and SWL; consequently, the stent duration was prolonged.

Ureteral stricture is a serious late complication of URS that may be unrecognized owing to asymptomatic obstruction and may, subsequently, result in renal failure [49,50]. Its incidence in recent publications is 0.4–7.8%. [1,17,29,33,35,51–54]. In the current study, four (1.5%) of 263 procedures were complicated by

stricture, which was shown by CTU and confirmed by diuretic renogram.

The caliber of the ureteroscope in our study did not show significant association with the SFR or complications rate (P = 0.326 and 0.894, respectively). Similarly, Yaycioglu *et al.* [55] found no differences in terms of complications, success, or failure rates between the 7.5-Fr and 10-Fr ureteroscopes. The only statistically significant difference was that the basket catheter was used more frequently in the 7.5-Fr group compared with the 10-Fr group (92 vs. 67%, P = 0.029). This difference was attributed by the author to the larger fragments created by the smaller-caliber pneumatic probe used with the 7.5-Fr ureteroscope which required surgeons to use the basket for extraction of these fragments [55].

These findings are contradictory to a retrospective study performed by Kilinc *et al.* [56] in 2016 that compared between the 10/10.5 Fr Storz, 8.9/9.8 Fr Storz, and 6/7.5 Fr Wolf ureteroscopes, and found that the use of smaller-caliber ureteroscopes led to significantly higher SFR (83.7, 87.4, and 92.2%, respectively, P = 0.01) and lower overall complications rate (10.8, 7.6, and 6.9%, respectively, P = 0.01). Nevertheless, the rate of postoperative stenting was significantly higher and operative times were significantly longer when the ureterescope caliber was reduced (P = 0.01) [56].

Furthermore, some authors found significant correlation between larger size of ureteroscope and higher rates of perforation [2,26].

In our study, the use of Dormia basket to remove fragments after lithotripsy was significantly associated with more incidence of early postoperative but not intraoperative complications (P = 0.001 and 0.747, respectively).

Tanriverdi *et al.* [18] found that adhering to the 'break'n'leave' policy was responsible for significantly decreased intraoperative complications rate during ureteroscopic treatment of ureteral stones. This policy was defined by the authors as the termination of the procedure when the residual stone fragments are small enough (≤3 mm) to pass spontaneously. This policy, as explained by the authors, reduced the complication rate by avoiding the effort of continuing fragmentation and/or the excessive use of forceps or baskets to extract insignificant fragments [18].

Using the semirigid ureteroscope for all procedures is a limitation of our study as the outcomes of flexible URS were not assessed.

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Conflicts of interest

There are no conflicts of interest.

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