Original Article

Ureteral stricture after ureteroscopy for stones: A prospective study for the incidence and risk factors

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Abstract

Context: A ureteral stricture is a serious complication of ureteroscopy (URS) that was reported in the literature in highly variable rates from 0.2% to 24%.

Aims: Our aims are to estimate the incidence and to detect the risk factors of ureteral stricture after URS.

Settings and Design: This is a prospective, case-series study.

Materials and Methods: During the period from May 2015 to August 2016, 251 adult patients underwent 263 URS for the treatment of 304 ureteral stones. Postoperative regular follow-up was done for 12 months by ultrasound. Computed tomography urography and diuretic renogram were performed for the cases developed hydronephrosis to confirm and detect the level of the stricture.

Statistical Analysis: IBM SPSS Statistics for Windows, Version 19.0, Armonk, NY: IBM Corp. used for data analysis. Chi-square and Fisher's 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 <0.05.

Results: The mean age was 43.5 years (standard deviation [SD]: ±13.6), and the mean body mass index was 28.39 (±3.96). The mean total stone burden was 12.8 mm (SD: ±5.9). Bilateral URS was performed in 12 cases. The mean operative time was 54.8 min (SD: ±22.68). Initial and final stone-free rates were 83.3% and 100%, respectively. The overall complications rate was 28.1%. Stricture occurred in four cases (1.5%).

Conclusions: In our experience, the incidence of post-URS ureteral stricture is low. The impacted stone is the most common cause of URS complications and hence stricture formation.

Keywords: Ureteral stones, ureteral stricture, ureteroscopy

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INTRODUCTION

Urolithiasis is a globally prevalent disease with an increasing worldwide prevalence (4%–5%).[1,2] Ureteroscopy (URS) was subjected to multiple refinements which led to higher success rates and lower complications rate.[3] Ureteral stricture has been reported with highly variable rates ranging from 0.2% to 24%.[4,5]

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The literature shows obvious controversies regarding risk factors of the post-URS stricture.[6,7] The majority of studies are retrospective with short follow-up.[8-10] Herein, we prospectively evaluate the incidence and risk factors of ureteral stricture after URS in a relatively large number of patients and longer follow-up period.

MATERIALS AND METHODS

This is a descriptive, case-series study that includes 251 adult patients who underwent URS for ureteral stone (s) from May 2015 to August 2016 in our hospital. Patients who had associated ipsilateral renal stone, single ureteral stone <5 mm (possibility of ureteral stricture with secondary stone), total stone burden >35 mm, history of previous ureteroneocystostomy or ureteroureterostomy, signs of urinary bilharziasis in preoperative imaging, and/or intraoperatively diagnosed ureteral stricture either during retrograde pyelography (RPG) or endoscopically were excluded from the study.

The sample size was calculated using Epi Info™ version 3.5 (Centers for Disease Control and Prevention (CDC), Atlanta, GA, USA) with 95% power to detect 5% difference in the mean stricture ureter after URS for stones and a threshold of significance of 0.05. The sample size had to be 134 patients.

Detailed history, clinical examination, abdominal ultrasonography (U/S), plain-kidney, ureter and bladder (KUB), noncontrast computed tomography (NCCT), urinalysis and urine culture, routine preoperative laboratory investigations, and surgical fitness were done for all cases. Authors had permission from the local ethics committee before conducting this study, together with written informed consent from all patients.

Stones were considered impacted when they were present at the same site for >2 months, caused moderate or severe hydronephrosis by preoperative U/S, caused obstructive anuria, and/or diagnosed intraoperatively as impacted stones where there was difficulty in passing a standard guidewire beyond the level of the stone at the first trial.[8,11,12]

Under spinal or general anesthesia, together with prophylactic three-generation cephalosporin, the patient was placed in dorsal lithotomy position. When the ureteral orifice identified; the Sensor™ guide wire (Boston Scientific, Natick, MA, USA) was introduced. If the ureter was tight, it was dilated by either Teflon or balloon dilators. After that, a semi-rigid ureteroscope with an offset eyepiece, tip diameter of either 6 or 8.5 Fr, and length of either 31.5 or 43 cm was introduced. If the ureter is still tight, a ureteral stent was inserted and the procedure aborted for 2 weeks and re-URS performed.

The stone was either extracted by Dormia basket or disintegrated by pneumatic lithotripter (PL) or laser lithotripter (LL). Stone fragments were extracted for analysis. Ureteral stenting was done according to the situation. Finally, fluoroscopic confirmation of correct stent position and stone clearance was done; 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).

Intraoperative data including any complications were recorded in the patient sheet. The term mucosal abrasion was used to describe the small superficial mucosal tears that are not extending beyond mucosa. The term false passage was used when an instrument or accessory perforates the mucosa, without penetrating the whole ureteral wall.[13]

Plain KUB and U/S were done on the 1st postoperative day for documentation of stone-free status and correct stent position. The ureteral catheter was removed before patient discharge while patients with double-J (JJ) stent were instructed to come back for stent removal on a specific date.

The patients were requested for postoperative follow-up at the outpatient clinic on 4 separate visits every 3 months. On the first visit which was 3 months following stent removal, urine analysis with or without culture and U/S were performed. On the following three visits, patients were followed up by U/S only.

When U/S showed backpressure, CT urography (CTU) was done to show the cause and level of obstruction. When ureteral stricture was shown or suspected, diuretic renogram was done to confirm the presence or absence of obstruction.

Post-URS ureteral stricture in this study was defined as complete or partial ureteral obstruction as shown by the excretory phase of CTU, which was confirmed with delayed or absent radioactive tracer washout in diuretic renogram at least 3 months after stent removal.

Data entry was done using Microsoft Excel 2015 and 2016 versions while data analysis was done using IBM SPSS Statistics for Windows, Version 19.0 (IBM Corp., Armonk, NY). Chi-square and Fisher's 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 <0.05.

RESULTS

A total of 263 URSs were performed for the management of 251 patients with 304 ureteral stones. The mean (standard deviation [SD]) age was 43.45 (±13.57) years. The mean (SD) body mass index was 28.39 (±3.96). Patients' characteristics are summarized in Table 1.

The mean (SD) total stone burden was 12.8 mm (±5.9). Bilateral URS was done in 12 cases. URS for multiple ureteral stones performed in 34 (12.9%) cases. Impacted stones were detected in 49 (18.6%) procedures. Preoperative stone and urinary tract characteristics are shown in Table 2. The mean (SD) operative time was 54.77 (±22.68) min. As regard postoperative ureteral stenting, 253 (96.2%) cases were stented (ureteral catheter in 101 cases and JJ stent in 152) and 10 (3.8%) cases were not stented. The median (range) stent duration was 40 (1–180) days. Intraoperative details are shown in Table 3.

Table 1: Preoperative patient's characteristics

	n (%)
Gender	
Male	183 (72.9)
Female	68 (27.1)
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)
CKD	6 (2.4)
Morbid obesity	1 (0.4)
IHD	5 (2)
Mixed	6 (2.4)
Laterality	
Unilateral	239 (95.2)
Bilateral	12 (4.8)

LUTS: Lower urinary tract symptoms, UTI: Urinary tract infection, DM: Diabetes mellitus, HTN: Hypertension, CKD: Chronic kidney disease, IHD: Ischemic heart disease, BMI: Body mass index

The initial and final stone-free rates (SFRs) were 83.3% and 100%, respectively. The overall complications rate was 28.1%. There were 61 out of 263 (23.2%) procedures where intraoperative complications occurred; the complications are summarized in Table 4. Multivariable analysis using logistic regression test revealed that only impacted stones and longer duration of stent had a significant association with intraoperative complications as shown in Table 5.

Stricture occurred after 4/263 (1.5%) procedures. It was suspected by the development of hydronephrosis on U/S and documented by CTU, diuretic renogram, and later on RPG. Three procedures were associated with preoperative hydronephrosis. Stones were located at lower one-third of the ureter in two cases, middle one-third in one case, and upper one-third in another. Stones were impacted in three cases. The 8.5/11.5 Fr ureteroscope was used in all these four procedures. Active ureteral dilatation was done in three procedures. None of these procedures were associated with intraoperative perforation. Three procedures were JJ stented. Three of these procedures were associated with postoperative ipsilateral loin pain and one case of silent obstruction. Stricture occurred at the same level of stone impaction. No significant association between stricture and any of variables could be revealed, and this can be largely explained by the few numbers of stricture cases.

DISCUSSION

A ureteral stricture is a late and serious complication of URS that may be a silent process which may lead to progressive loss of ipsilateral renal function.[14] In the current study, four out of 263 procedures (1.5%) were complicated by stricture which was shown by CTU and confirmed by diuretic renogram.

Stone impaction is the main predictor for the development of stricture. Taş *et al.* found that ureteral stricture was observed in 13.3% of patients with impacted calculi and in 5% of patients who did not have impacted calculi ($P < 0.05$).[15] In a retrospective study, Elashry *et al.*, reported 12 cases (0.4%) of ureteral stricture out of 3215 ureteroscopies performed for treatment of distal ureteral stones; notably, all 12 strictures had impacted ureteral calculi.[3] In the current study, three out of 4 (75%) procedures that were complicated by stricture in this study were performed for treating impacted stones.

Larger stone size is another risk factor for stricture formation. El-Abd *et al.* found that large stone size is

Table 2: Preoperative stone and urinary tract characteristics

	n (%)
Previous ipsilateral stone intervention/stone pass	
None (primary stone disease)	171 (65)
ESWL	33 (12.5)
URS	23 (8.7)
Trial URS-failed	2 (0.8)
Open ureteral surgery	47 (17.9)
Stone pass	6 (2.3)
Serum creatinine at time of procedure	
Raised	22 (8.4)
Normal	241 (91.6)
Prestenting	
Not prestented	226 (90.5)
Prestented	25 (9.5)
Raised serum creatinine	17 (6.5)
Failed 1st procedure	2 (0.8)
Obstructive PN	6 (2.3)
Single stone	229 (87.1)
Stone multiplicity	
Multiple	34 (12.9)
2 stones	27 (10.3)
3 stones	7 (2.7)
Side	
Right	134 (51)
Left	129 (49)
Total stone burden (mm)	
5-10	100 (38)
10-15	89 (33.8)
15-25	59 (22.4)
25-35	15 (5.7)
Radio-opacity	
Radio-opaque	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)
Degree of hydronephrosis	
None	19 (7.2)
Mild	108 (41.1)
Moderate	106 (40.3)
Marked	30 (11.4)

ESWL: Extracorporeal shock wave lithotripsy, URS: Ureteroscopy, PN: Pyelonephritis

significantly related to increased incidence of stricture. Stricture developed in 4.4% of patients with stones larger than 2 cm compared to 0.2% of patients with stones less than 2 cm in size.[4] In the current study, the mean stone burden in the four procedures complicated by stricture was 16 mm, with an overall incidence of 1.5%. Taş *et al.* found a significant association between JJ insertion and development of ureteral stricture among patients undergoing PL for distal ureteral stones.[15]

Our findings revealed that a JJ stent was inserted at the end of three procedures out of four procedures that were complicated by stricture. In the fourth procedure, only the ureteral catheter was inserted.

The association between JJ insertion and stricture may be explained by that the presence of stone impaction and/or intraoperative ureteral trauma are usually indications of JJ stenting and also are considered important risk factors for the development of stricture.[15-17]

The association between ureteral perforation and stricture remains a point of debate in the literature. Some studies demonstrated that perforation was a significant predictor for the development of ureteral stricture.[4,5] However, other studies found no correlation between perforation and development of ureteral stricture.[7,8] In our study, ureteral perforation was not observed during any of the four procedures that were complicated by stricture.

Regarding the size of the ureteroscope, there is a contradiction in the literature. Some stated that the bigger the ureteroscope size, the higher the incidence of stricture; others found no correlation.[18,19] In our study, in spite of using the 8.5 Fr tipped ureteroscope in the four cases who developed stricture, the caliber of the ureteroscope was not a significant predictor of neither complications, SFR, nor stricture rate.

Li *et al.* found that LL was associated with more incidence of post-URS stricture than PL in the treatment of middle and distal ureteral stones.[20] In the current study, stone fragmentation was done in 3 (75%) out of 4 (LL in 2 and PL in 1) procedures that were complicated by stricture.

In our study, the use of Dormia 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). Further, Dormia has used in three out of 4 (75%) procedures where stricture developed later on.

In a study by Taş *et al.*, ureteral dilatation was not a significant risk factor for the development of ureteral stricture.[15] Contrarily, Adiyat *et al.* found that ureteral dilatation was a significant risk factor for the development of ureteral stricture.[16] Our results revealed that Teflon dilatation was done in 3 (75%) out of 4 procedures that were complicated by stricture. These represent 1.3% of total procedures that required ureteral dilatation.

Postoperative renal pain was observed after five procedures (1.9%) in our study. Three of them developed stricture. There was one silent stricture which was discovered only during postoperative surveillance. Pain after stent removal was a significant predictor for stricture in one study which revealed 99.8% and 64.3% negative and positive predictive value for pain, respectively.[14] In

Table 3: Intra-operative variables

	n (%)
Type of anesthesia	
General	71 (27)
Spinal	192 (73)
Ureteroscope diameter	
8.5-11.5 Fr.	200 (76)
6-7.5 Fr.	63 (24)
Active ureteral dilatation	
Balloon	72 (27.4)
Teflon	162 (61.6)
Up to 10 Fr	17 (6.5)
Up to 12 Fr	80 (30.4)
Up to 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)
JJ stent	152 (57.8)
Ureteric catheter	101 (38.4)

PL: Pneumatic lithotripsy, LL: Laser lithotripsy, JJ: Double J

Table 4: Complications and unfavorable incidents

	n (%)
Intraoperative complications**	
No	202 (76.8)
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	
No	234 (89)
Fever	10 (3.8)
UTI requiring shift of antibiotic	8 (3)
Pain/colic	4 (1.5)
Hematuria	7 (2.7)
Total procedures with postoperative complications	29 (11)
Late postoperative complications	
Stricture	4 (1.5)

**In some procedures, there was more than 1 intraoperative complication. UTI: Urinary tract infection

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

*Significant $P<0.05$. CI: Confidence interval, OR: Odds ratio

contrast, Adiyat *et al.* found that pain after stent removal was not a significant predictor for the development of stricture.[16]

The relatively small number of post-URS stricture in our study was so small that no significant relations could be found between perioperative variable. Moreover, all our procedures were performed by semi-rigid ureteroscopes. Therefore, the outcomes of flexible URS in the management of ureteral calculi were not assessed.

The use of fluoroscopy for guidance of all URS procedures, use of small caliber URS, and routine postoperative U/S for a period not <12 months are recommended.

CONCLUSION

We can conclude that post-URS ureteral stricture incidence is low provided that all the requirements for safe URS are available. The impacted stone is the most common cause of URS complications and hence stricture formation, but we are still in need for large randomized controlled studies to define the risk factors for stricture formation.

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Conflicts of interest

There are no conflicts of interest.

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