Fluoroless Ureteroscopy: Experience in More Than 100 Patients

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ABSTRACT

Background: Ureteroscopy is becoming the primary treatment for ureteral stones. As a standard of care, ureteroscopy is performed under the supervision of fluoroscopy. Recent advances in endourological technology make the need for fluoroscopy questionable.

Objectives: To summarize our experience with a no-fluoroscopy technique for selected cases of ureteral stones.

Methods: Patients were considered suitable for fluoroless ureteroscopy if they had one or two non-impacted stones, in any location in the ureter, 5–10 mm size, with a normal contralateral renal unit and no urinary tract infection. Procedures were performed using rigid scopes, nitinol baskets/forceps for stone retrieval, and Holmium:YAG laser for lithotripsy. Stents were placed per surgeon's decision.

Results: During an 18-month period, 103 patients underwent fluoroless ureteroscopy. In 94 patients stones were removed successfully. In six, the stones were pushed to the kidney and treated successfully on a separate session by shock wave lithotripsy. In three patients no stone was found in the ureter. In five patients, miniature perforations in the ureter were noted and an indwelling double J stent was placed.

Conclusions: Fluoroless ureteroscopy resulted in a high rate of success. We believe that in selected cases it can be used with minimal adverse events.

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KEY WORDS: fluoroscopy, irradiation exposure, lithotripsy, ureterolithiasis, ureteroscopy

Ureteral stones are the main cause of ureteral obstruction and symptomatic renal colic [1,2]. The definitive treatment of these stones depends on their size, radio-opacity, and location [3]. Stones smaller than 5 mm are usually treated conservatively. Stones 5–7 mm in size are given a chance of spontaneous expulsion, with or without adjunctive treatment with alpha adrenergic blockers [4], and stones larger than 7 mm are referred for definitive treatment [5].

Traditionally, stones in the upper ureter have been referred to extra corporeal shock wave lithotripsy (SWL) and stones in the middle ureter to ureteroscopy. Distal ureteral stones can be treated with both modalities. The choice of treatment modality is based factors such as patient's body habitus and equipment's availability. Recent progression in the fields of flexible ureteroscopy, retrograde intra renal surgery (RIRS), and the introduction of high intensity dusting lasers, facilitated the use of endoscopy for the management of ureteral stones [1,6].

In addition to the advances in flexible endoscopy, classic rigid ureteroscopy benefitted significantly from the improvement in optical clarity and downsizing of instruments. The use of high definition systems, mounted on thin scopes (4.5-6 Fr.) allows rapid and safe inspection of the ureter. Older devices, often as thick as 11 Fr., required pre-stenting of the ureter to promote ureteral dilatation [7].

The use of fluoroscopy during ureteroscopy is the standard of care [4,8]. The obvious benefits are localization of the stones, performing retrograde pyelography to demonstrate the ureteral course, and passing additional guide wires and stents. However, stone disease is chronic and recurrent stone forming patients will undergo multiple interventions exposing them to high dose of irradiation during procedures and follow up imaging. Endourologists, who specialize in stone disease management, are exposed to significant accumulating doses of irradiation during their career. Therefore, in the treatment of stone disease, physicians should adopt the ALARA (As Low As Reasonably Achievable) principles and minimize the use of irradiation. With modern imaging and high definition scopes, this task is achievable. In an effort to do so, several groups described their experience with minimal to zero fluoroscopy [9-11].

Our own impression is that the routine use of fluoroscopy does not necessarily contribute to the procedure and is not justified. Therefore we decided to perform fluoroless ureteroscopy (f-URS) in selected case. We summarized our experience in a series of 103 f-URS patients.

PATIENTS AND METHODS

This retrospective analysis of a cohort describes patients who were treated at Ziv Medical Center between January 2016 and December 2018. Patients were referred to ureteroscopy due to an obstructing ureteral stone. A fully equipped endourology suite was available for treatment including a mobile fluoroscopy unit. We decided to consider a fluoroless approach in patients with a single 5–10 mm ureteral stone, normal contra-lateral kidney, normal renal function and no evidence of urinary tract infection. We excluded patients with a suspected impacted ureteral stone, previous ureteral surgery or stricture and external compression of the ureter.

Patient evaluations included a Kidney-Ureter-Bladder plain film (KUB), a non-contrast CT scan (NCCT), renal function tests, and urine cultures. In patients with urinary symptoms above 4 weeks, a dimercapto succinic acid (DMSA) renal scan was performed to assess baseline renal function, and verify that there was no loss of a renal unit. DMSA scans remain accurate in the presence of obstruction [12]. All patients with radio-opaque stones repeated the KUB in the evening before the procedure, to verify the position of the stone.

Pre-operatively, all patients had to have a sterile urine culture. A single dose of garamycin 5 mg/kg and a single dose of cefazolin 2 grams were given 60 minutes before the procedure.

Patients were operated under general or regional anesthesia in the lithotomy position. Ureteroscopy was performed with rigid 8-9.8Fr (in a dilated or pre stented ureter) or a 6.5–7 Fr ureteroscope (Richard Wolf GmbH, Germany). We routinely used the semi-rigid scopes for all the levels or the ureter and used flexible devices for pelvic or calyceal stones. The instruments were inserted into the ureter directly over a glide wire (Zebra wire, Boston Scientific, Massachusetts, USA) without dilatation of the ureteral orifice. The ureter was inspected for the presence of stones. If no stone was found in the expected site according to KUB and NCCT, complete inspection of the ureter was performed. Although the procedure was planned as fluoroless, a fluoroscopy device was available in the OR suite for the surgeons request.

Small floating stones in a dilated ureter were extracted using a nitinol basket (3Fr, straight end, zero tip, 4 wires, Cook Medical/Boston Scientific, USA). Larger stones adhering to the ureteral wall were defragmented using laser (Dornier Medilas 20W, non-dusting, 400 micron fibers). Safety guide wires were used according to the surgeon's discretion. Stents were not placed routinely. If the surgeon suspected significant edema of the orifice, a 5 Fr externalized ureteral catheter was left for 24 hours. If the surgeon felt that stenting was necessary, a double J ureteral stent was inserted through the scope and placed also without fluoroscopy. In order to perform that, a 4.8 F stent was used (Percuflex, Boston Scientific, USA) and a 5 Fr ureteral catheter was used as a pusher. The scope was placed in the renal pelvis, the stent was advanced over a glide wire through the scope and the scope was retracted backwards while pushing the ureteral catheter forward. Once in the bladder, the glide wire was removed, the coiling of the distal tip of the stent was noted and the instrument was removed. A Foley catheter was placed until the next morning. A KUB was performed the next day to assure proper positioning of the stent.

Patients were discharged on the next day with instruction for a high liquid intake and analgesics as required. First follow-up visit was performed after 3 weeks with a KUB for patients with a radio-opaque stone. Patients with radiolucent stones were referred to urinary tract ultrasound including ureteral jet sign assessment. A second follow-up visit was performed after 3 months and patients were assessed with urine cultures, serum creatinine level, and a NCCT.

RESULTS

During an 18 months period, 216 patients were referred for ureteroscopy. Of this group, 103 patients underwent f-URS, 25 women and 78 men. Patient mean age was 47 years (range 28–78); 21 stones were located in the upper ureter, 8 in the middle, and 63 in the lower ureter. In 11 cases there was more than one stone found in different locations. Average stone size was 6.3 mm (range 4–10). 10 patients were pre-stented.

In 94 patients (91.2%), the stone was removed successfully. In 6 patients (5.9%) the stone was pushed to the kidney and treated on a separate session by SWL. Five were found in the upper ureter and one in the middle ureter [Table 1]. No patient returned with ureteral obstruction and SWL was further used successfully. In 3 patients (2.9%) no stone was found in the ureter and later on imaging.

Table 1. Characteristics of six male patients, aged 30–76 years, in whom the stone returned to the kidney

Side	Level in the ureter	Stone size in mm
Left	Middle	5
Left	Upper	6
Left	Upper	6
Left	Upper	12
Left	Upper	5
Left	Upper	5

Table 2. Characteristics of five male patients, aged 24–78 years, who presented with ureteral perforation

Side	Level in the ureter	Stone size in mm	Method of stone removal
Left	Lower	4	Laser
Right	Middle	7	Laser
Left	Upper	7	Forceps
Right	Lower	5	Forceps
Right	Lower	10	Laser

INTRAOPERATIVE COMPLICATIONS

All procedures were completed as f-URS and there was no conversion for a fluoroscopy guided procedure.

In 5 patients (4.8%) small perforations in the ureter were noted during the ureteroscopy session and an indwelling double J ureteral catheter was placed [Table 2]. All stents were removed after 6 weeks and repeated NCCT showed a normal kidney and ureter, without residual stones, hydronephrosis or urinoma formation.

POSTOPERATIVE COMPLICATIONS

Three patients presented with fever after the procedure despite sterile cultures and antibiotic coverage. They had a repeated NCCT to verify that there were no residual fragments in the ureter. Repeated urine and blood cultures came back negative.

Average procedure time was 18.4 minutes (range 4–50, median 16). In total, 100 patients stayed in the hospital overnight and were discharged the next morning. The three patients who had fever remained in hospital for additional 3 days.

Average follow-up period was 3 months, following a satisfactory clinic visit and a stone free NCCT. The patients were referred to their local urologist for further treatment.

DISCUSSION

Out of 216 consecutive patients who were referred for ureteroscopy at a community hospital, 103 underwent f-URS. These results reflect the common practice rather than the experience of a tertiary high volume center.

The other 113 patients underwent ureteroscopy with the use of fluoroscopy due to multiple factors such as an impacted stone, stones larger than 10 mm in diameter, or suspected ureteral stricture. Therefore we did not attempt to compare the fluoroscopy to the f-URS cases.

In our series, in 94 cases the stone was retrieved successfully. Only in 6 patients (5.9%) was the stone pushed to the kidney. Five of these stones where in the upper ureter. We elected to treat these stones with SWL at a separate session. Overall we found 21 upper ureteral stones, of which 16 were treated successfully. All the SWL sessions were successful without any adverse effects.

We did not notice any significant difference reaching upper versus lower ureteral stones. Using thin rigid scopes, inspection of the entire ureter is feasible. This method is even easier with a pre-stented ureter. We did not use a flexible scope for ureteral stones and did not encounter any problems in fragmenting the stones. The use of the Dornier laser was satisfying.

In five patients (4.8%) small perforations in the ureter were noted during the ureteroscopy session. They were all minor perforations and visually identified. They were caused by laser burns in three cases or mechanical pressure in two. Ureteral stenting was performed without fluoroscopy and resulted in no adverse effects. Repeated NCCT showed a normal kidney and ureter, without residual stones, hydronephrosis, or urinoma formation.

PATIENT EXPOSURE TO RADIATION

It is estimated that following a stone related episode, the annual risk of repeated episode is as high as 12% [13,14]. Since most of the modalities used to evaluate and treat stone disease use ionizing irradiation, the lifelong exposure of these patients is significant. Ferrandino and colleagues [15] calculated that the median annual irradiation exposure related to imaging of urolithiasis patients is as high as 29.7 miliSievert (mSv) and 20% of the patients are exposed to more than 50 mSv. Lipkin and co-authors [16] calculated that ureteroscopy session involves an average of 1.13 mSv. Obesity significantly increases the amount of radiation required [17], and ureteroscopy is the treatment of choice in obese patients presenting with ureteral stones [5]. Thus, such patients are prone to excessive radiation exposure. Ferrandino estimated that in urolithiasis patients aged 48 years on average experience radiation exposure related to a single stone episode, which increases the lifelong overall risk for malignancy in 0.15% [15]. Physicians are committed to the ALARA principles while treating patients using radiation [18].

SURGEON EXPOSURE TO RADIATION

Traditional endourological procedures rely on fluoroscopy. According to the International Commission on Radiological Protection (ICRP) the maximum-allowable occupational radiation dose is 50 mSv per year. Exposure to more than 50 mSv induces approximately 1 additional fatal cancer per year in every 500 people exposed [19]. Additional risks are eye injury and early cataract formation, hypothyroidism, or gonadal dysfunction. Appropriate protective gear can efficiently reduce the risk yet lack of knowledge or inadequate training may lead to misuse of such devices and a false sense of security [20].

Cohen et al. [21] showed that an experienced academic urologist remains below the annual limit of radiation exposure of 50 mSv. Yet experienced urologists need less fluoroscopy. In high volume centers, with residents and other trainees employed as well as more complicated cases, the radiation exposure is likely to increase.

IS THERE A REAL NEED FOR FLUOROSCOPY IN ALL THE STEPS OF URETEROSCOPY?

Traditionally, ureteroscopy begins with cystoscopy and retrograde ureteropyelography. We stopped this routine procedure several years ago when performing ureteroscopy for a non-impacted stone in a naïve ureter. Not only was there no valuable information from this procedure, a stone may easily be pushed back as far as the kidney from a simple flush of contrast material, turning a simple ureteroscopy for a distal stone to a complex RIRS case.

Dilatation of the ureteral orifice is hardly necessary and is a remnant from earlier periods when 11F ureteroscopes were the standard. Pre-stenting of the ureter results in a well dilated ureter and the use of thin and ultra-thin scopes allow ureteral access without dilatation.

When metal coated guide wires are used, fluoroscopy is advocated due the possible risk of ureteral perforation and false passage. The routine use of hydrophilic glide wires significantly reduces this risk. It is easy to insert a thin scope into the ureter, place a hydrophilic glide wire through it, and advance along the ureter under visual control. It is possible then to retract the scope, leaving the glide wire for safety, and re-enter the ureter with an additional wire, if required.

In a similar fashion, a 4.8 F double J stent can be placed through a 9.8 Fr ureteroscope (which has a working channel diameter of 5.2 Fr) without fluoroscopy just by placing the tip of the scope can be placed at in the renal pelvis, passing the stent through it and withdrawing the scope while pushing the stent forward. The coiling of the lower part of the stent is easily visible when exiting the ureteral orifice [22].

In a randomized controlled trial, Mohey et al. [11] compared 74 cases of a single 5–10 mm stones treated without fluoroscopy in 80 cases in which fluoroscopy was used. There was no difference between the groups in terms of stones size and location, and no difference in patient characteristics. Our results showed that the two groups achieved the same odds ratio time, the same stone free rate, and the same rate of overall complications. In the study group there was a significant decrease in fluoroscopy time when only 6 of 74 patients eventually required the use of fluoroscopy during the procedure [12].

The endourological approach is the mainstay treatment of ureterolithiasis. The routine use of fluoroscopy during endourological exposure results in a significant lifelong exposure to radiation with potential hazards to patients and urologists.

CONCLUSIONS

With current state-of-the-art endourological scopes and accessories, simple cases of ureteral stones (no previous structures, small non-impacted stones) can be performed with minimal to no fluoroscopy, with good results and a low incidence of complications, while promoting patient and surgeon safety.

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References

1. Geraghty RM, Jones P, Herrmann TRW, Aboumarzouk O, Somani BK. Ureteroscopy is more cost effective than shock wave lithotripsy for stone treatment: systematic review and meta-analysis. *World J Urol* 2018; 36 (11): 1783-93.
2. Fukuhara H, Ichiyanagi O, Kakizaki H, Naito S, Tsuchiya N. Clinical relevance of seasonal changes in the prevalence of ureterolithiasis in the diagnosis of renal colic. *Urolithiasis* 2016; 44 (6): 529-37.
3. Jendeberg J, Geijer H, Alshamari M, Cierzniak B, Lidén M. Size matters: The width and location of a ureteral stone accurately predict the chance of spontaneous passage. *Eur Radiol* 2017; 27 (11): 4775-85.
4. Campschroer T, Zhu X, Vernooij RW, Lock MT. Alpha-blockers as medical expulsive therapy for ureteral stones. *Cochrane Database Syst Rev* 2018; 4: CD008509.
5. Türk C, Petřík A, Sarica K, et al. EAU Guidelines on interventional treatment for urolithiasis. Eur Urol 2016; 69 (3): 475-82.
6. Humphreys MR, Shah OD, Monga M, et al. Dusting versus basketing during ureteroscopy-which technique is more efficacious? a prospective multicenter trial from the EDGE research consortium. *J Urol* 2018; 199 (5): 1272-6.
7. Uzun H, Akça N. Is the 4.5-F ureteroscope (Ultra-Thin) an alternative in the management of ureteric and renal pelvic stones? *Arab J Urol* 2018; 16 (4): 429-34.
8. Yecies TS, Fombona A, Semins MJ. Single pulse-per-second setting reduces fluoroscopy time during ureteroscopy. *Urology* 2017; 103: 63-7.
9. Hsi RS, Harper JD: Fluoroless ureteroscopy: zero-dose fluoroscopy during ureteroscopic treatment of urinary-tract calculi. *J Endourol* 2013; 27 (4): 432-7.
10. Kocaaslan R, Tok A, Kalkan S, Tasci Aİ. Fluoroless ureteroscopy: in whom and when? *Urolithiasis* 2015; 43 (5): 477-8.
11. Mohey A, Alhefnawy M, Mahmoud M, et al. Fluoroless-ureteroscopy for definitive management of distal ureteral calculi: randomized controlled trial. *Can J Urol* 2018; 25 (1): 9205-9.
12. Pohl HG. Pediatric urogenital imaging. In Campbell-Walsh-Wein Urology, chapter 24. Philadelphia: Elsevier Inc., 2021: 403-25.
13. Weld LR, Nwoye UO, Knight RB, et al. Safety, minimization, and awareness radiation training reduces fluoroscopy time during unilateral ureteroscopy. *Urology*. 2014; 84 (3): 520-5.
14. Abu-Ghanem Y, Kleinmann N, Winkler HZ, Zilberman DE. Nephrolithiasis in Israel: epidemiological characteristics of return patients in a tertiary care center. *IMAJ* 2016; 18 (12): 725-8.
15. Ferrandino MN, Bagrodia A, Pierre SA, et al. Radiation exposure in the acute and short-term management of urolithiasis at 2 academic centers. *J Urol* 2009; 181: 668-72.

16. Lipkin ME, Preminger GM. Imaging techniques for stone disease and methods for reducing radiation exposure. *Urol Clin North Am* 2013; 40: 47-57.
17. David L. Wenzler, Joel E. et al, Predictors of radiation exposure to providers during percutaneous nephrolithotomy. *Urol Ann* 2017; 9 (1): 55-60.
18. Bryant PA, Croft J, Cole P. Integration of risks from multiple hazards into a holistic ALARA/ALARP demonstration. *J Radiol Prot* 2018; 38 (1): 81-91.
19. 1990 Recommendations of the International Commission on Radiological Protection. *Ann ICRP* 1991; 21 (1-3): 1-201.
20. Kim CH, Kim SJ, Kim MH, et al. Are urologists performing semi-rigid ureteroscopic lithotripsy safe from radiation exposure? a guidance to reduce the radiation dose. *Urology* 2016; 95: 54-9.
21. Cohen SA, Rangarajan SS, Chen T, Palazzi KL, Langford JS, Sur RL. Occupational hazard: radiation exposure for the urologist--developing a reference standard. *Int Braz J Uro.* 2013; 39 (2): 209-13.
22. Shuaibu SI, Gidado S, Oseni-Momodu E. Endoscopic retrograde JJ-stenting of the ureter without fluoroscopy guidance--an appraisal of outcome. *Niger J Med* 2013; 22 (4): 348-50.

Capsule

Vaccine effectiveness against life-threatening influenza illness in US children

Predominance of 2 antigenically drifted influenza viruses during the 2019–2020 season offered an opportunity to assess vaccine effectiveness against life-threatening pediatric influenza disease from vaccine-mismatched viruses in the United States. **Olson** and colleagues enrolled children aged < 18 years, who had been admitted to the intensive care unit with acute respiratory infection across 17 hospitals. The authors enrolled 159 critically ill influenza case-patients (70% ≤ 8 years of age; 51% A/H1N1pdm09 and 25% B-Victoria viruses) and 132 controls (69% ≤ 8 years of age). Among 56 sequenced A/H1N1pdm09 viruses, 29 (52%) were vaccine-mismatched (A/H1N1pdm09/5A+156K) and 23 (41%) were vaccine-matched (A/H1N1pdm09/5A+187A,189E). Among sequenced B-lineage viruses, the majority (30 of 31) were vaccine-mismatched. Effectiveness against critical influenza was 63% (95% confidence interval [95%CI], 38%–78%) and similar by age. Effectiveness was 75% (95%CI 49%–88%) against life-threatening influenza vs. 57% (95%CI, 24%–76%) against non-life-threatening influenza. Effectiveness was 78% (95%CI 41%–92%) against matched A(H1N1)pdm09 viruses, 47% (95%CI -21%–77%) against mismatched A(H1N1)pdm09 viruses, and 75% (95%CI 37%–90%) against mismatched B-Victoria viruses.

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Capsule

Children develop robust and sustained cross-reactive spike-specific immune responses to SARS-CoV-2 infection

SARS-CoV-2 infection is generally mild or asymptomatic in children but a biological basis for this outcome is unclear. **Dowell** and colleagues compared antibody and cellular immunity in children (aged 3–11 years) and adults. Antibody responses against spike protein were high in children and seroconversion boosted responses against seasonal Beta-coronaviruses through cross-recognition of the S2 domain. Neutralization of viral variants was comparable between children and adults. Spike-specific T cell responses were more than twice as high in children and were also detected in many seronegative children, indicating pre-existing cross-reactive responses to seasonal coronaviruses. Importantly, children retained antibody and cellular responses 6 months after infection, whereas relative waning occurred in adults. Spike-specific responses were also broadly stable beyond 12 months. Therefore, children generate robust, cross-reactive and sustained immune responses to SARS-CoV-2 with focused specificity for the spike protein. These findings provide insight into the relative clinical protection that occurs in most children and might help to guide the design of pediatric vaccination regimens.

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