Original Article

Fluoroscopy-free double-J stent placement through ureteroscope working channel postuncomplicated ureteroscopic laser lithotripsy: A novel technique

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Abstract

Objectives: To report a technique for ureteroscopic laser lithotripsy (URSL) and retrograde placement of a double-J (DJ) stenting through the ureteroscope working channel without the use of a fluoroscope compared to the conventional technique.

Patients and Methods: Between June 2015 and December 2017, 170 patients selected for URSL for treatment of ureteral stones and DJ insertion was evaluated. Patients are divided into two groups according to the use of fluoroscopy. In Group A (100 patients), fluoroscope is used and group B (70 patients) without fluoroscopy guidance. In group B, URSL is performed first and followed by DJ insertion by the semi-rigid ureteroscope 8.5-11 Fr under vision without fluoroscopy.

Results: Stone free rate in 96% versus 94.3% for groups A and B respectively. This technique was successful in all the included patients: 166 retrograde DJ stenting post URSL for ureteric calculi and 4 cases for anuria. Group A are exposed to radiation with mean 26.6 seconds in URSL procedure and 4.8 seconds for DJ stenting. Group B was exposed to zero dose. For group A, the stents size was 6 Fr for 70% of patients and 15 % for 4.7 Fr and 15% for 7 Fr stenting. In Group B, stents of 4.7 Fr and length 24-26 cm were used in all patients. Failure of DJ insertion is reported in 9% for group A and 13 (18.5%) patients for group B.

Conclusions: This study report the feasibility and efficacy of the completely fluoroscopy free URSL and DJ stenting to treat ureteric stones.

Keywords: Fluoroless, stents, ureter, ureteroscopy

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INTRODUCTION

Ureteral stents have been frequently used in urological practice. Retrograde ureteral stenting is usually performed under both cystoscopic and fluoroscopic guidance.[1] There has been a growing awareness about the hazards of radiation associated with routine medical imaging and intraoperative exposure. This has prompted a search for alternate methods to reduce the exposure of the patient, endourologist, and intraoperative team to the harmful radiations.[2] The placement of double-J (DJ) stenting with fluoroscopic guidance exposes the patient and the operative team to significant amounts of radiation. Thus, it is important to evaluate the feasibility of DJ insertion without fluoroscopic image guidance. In this study, we report a new technique for retrograde DJ stenting using the ureteroscope working channel without fluoroscope guidance.

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PATIENTS AND METHODS

Between June 2015 and December 2017, ureteroscopy was performed on 170 patients. Patients are divided into two groups according to the use of fluoroscopy. In Group A (100 patients) fluoroscope is used and Group B (70 patients) without fluoroscopy guidance. All the patients were informed in detail about the aims and the procedures of the study and they signed a written informed consent prior inclusion into the study. The protocol and written informed consent were approved by the local ethical committee of our institute. Patient's perioperative information recorded included age at time of surgery, gender, laterality, presence of preoperative stent, stone location, and mean operative time and stone size. Outcomes analyzed included complication rates, stone-free rates (defined as no residual stone >4 mm), and repeat procedure rates. Inclusion criteria for ureteroscopic lithotripsy (URSL) were stone ureter <15 mm. Exclusion criteria were URSL without double-J (DJ) stenting. Patients for consideration for a fluoroscopy technique included ureteroscopy for malignancy, duplicated collecting systems, previously documented strictures, and treatment of nonurolithiasis-related conditions.

Technique for fluoroscopy-free ureteroscopy

All the patients received prophylactic parenteral third-generation cephalosporin antibiotics (Ceftriaxone) preoperatively. Under general or spinal regional anesthesia, the patient was placed in the lithotomy position. If a previous stent was in place, the existing stent was removed before the procedure. A semi-rigid ureteroscope 6–7.5 Fr was introduced to the desired ureteral orifice with a Termo glide guidewire (0.035 inch). The semi-rigid ureteroscope is advanced up to the stone level. Using tactile feedback, the glide wire was gently passed behind the stone with gentle back and forth movements up until resistance from contact with the kidney was encountered. The ureteroscope is removed and reintroduced again under vision to the level of the stone. Laser fiber is introduced (200–500 micron). Stone dusting procedure is started. The same technique is used but guided by fluoroscope in Group A.

Double-J insertion technique

For Group A, The insertion of the double-J stent is performed by cystoscope with lens 30° and guided by fluoroscope. Three sizes of stents (4.7, 6, and 7 Fr) are used in this technique according to surgeon preference and postprocedure ureteric conditions.

For Group B, we used a new technique, a DJ stent 4.7 Fr, 24–28 cm was inserted in the patients.

Technique

During URSL procedure, ureteric dilatation was performed by inserting ureteroscope 6–7.5 Fr (Richard Wolf Medical Instruments Corporation, USA), followed by 8.5–11 Fr under vision. The ureteroscope is passed to the renal pelvis or proximal location of the obstruction in the ureteral lumen, and then 4.7 Fr, 24–28 cm DJ stent (Marflow AG, Soodstrasse 57, 8134 Adliswil/Zurich, Switzerland), a guidewire (0.032 inch), and one pusher 70 cm [Figure 1a and b] are introduced into the ureteroscope working channel 5 Fr over the guidewire. A DJ stent is advanced over the guidewire until the proximal tip is seen running over the guidewire to the renal pelvis under vision. The ureteroscope is withdrawn slowly with the sustained pushing of the stent to deliver the upper coil in the renal pelvis under vision. When the 70-cm single pusher is not available, two pushers are used over the guidewire. The ureteroscope is withdrawn slowly from the ureter to the urinary bladder through the ureteric orifice until the lower coil is in the bladder. It is ensured that after the complete insertion of the stent, the tip of the pusher is seen outside the ureteroscope. The surgeon assistant is asked to withdraw the guidewire keeping the pusher in place in such a way that the tip is completely seen outside the ureteroscope. After the complete removal of the guidewire, the coil of the stent will be seen in the bladder. When endourologists use two pushers instead of the 70-cm pusher, the same technique is used but with some precautions. Care must be taken that the tip of the first pusher is seen at the tip of the ureteroscope. After the removal of the guidewire, the ureteroscope is removed from the patient. One pusher is removed from the tip of the ureteroscope and the other one from the back. At any

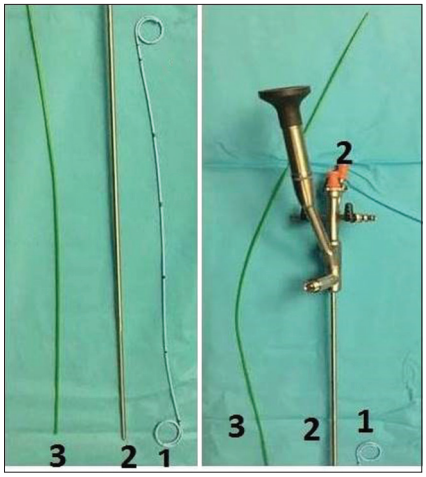

Figure 1: (a): (1) The whole length double-J stent with both coils, (2) the proximal part of ureteroscope, (3) proximal part of the pusher 70 cm, (b): (1) the proximal coil of the double-J stent, (2) the base of the ureteroscope with the working channels, (3) the extra length of the pusher of 70 cm which is exceeding the length of the ureteroscope

point during the procedure, if excessive resistance was encountered during guidewire or ureteroscope insertion, if wire lengths were not appropriate following placement, or if a tightly impacted stone was not amendable to passing the guidewire, the patient was converted to a low-dose fluoroscopy-guided technique.

Follow-up

All patients were followed up once at 2 weeks and then again at 3 months. The patients were subjected to imaging studies, plain abdominal radiograph of the kidneys, ureter, and bladder (KUB); ultrasound (US) was performed only if necessary. We used US-KUB instead of the X-Ray KUB to confirm the presence of the stent coil in the kidney and the urinary bladder to keep the procedure completely free of X-rays.

Complications

Complications were categorized into intraoperative (limited to inability to insert the stent or perform the URSL procedure properly) or postoperative complications (DJ migration, colic, hematuria, encrustation, and lower urinary irritative symptoms).

Statistical analysis

Data were analyzed using Microsoft Excel Office 2003 (Microsoft corp., Washington, USA) and Statistical Package for the Social Sciences version 22 (IBM, New York, USA), independent *t*-test, Mann–Whitney test, and Fisher exact test. Parametric data were expressed as mean ± standard deviation and nonparametric data were expressed as number and percentage of the total. The difference in proportions between theoretical and expected distribution was done using the Pearson's Chi-square tests; considering $P < 0.05$ is statistically significant and $P < 0.01$ is highly statistically significant.

RESULTS

The study included 170 patients (145 males and 25 females). There were 100 cases of fluoroscopy-guided retrograde URSL for ureteric calculi versus 70 patients without fluoroscopy guidance. Demographic data for the patients are recorded in Table 1. Indications of DJ stenting were post-URSL in 166 patients and 4 cases of anuria patients [Table 2]. The mean age of patients was 46.8 ± 3 (range 21–58) for Group A and 45 ± 34 (range 18–55) for Group B. Stone location was reported in the upper ureter (47.7%), middle ureter (9.4%), and the lower ureter (42.9%). Right side procedure was done in 74 (43.5%) patients and the left side was done in 96 (56.5%) patients. Stone impaction was reported in 30 (30%) in Group A and in 52 (74.3%) Group B. For Group A, the stents size was 6 Fr for 70% of

Table 1: Demographic data of the patients

	Group A control (*n*=100), *n* (%)	Group B (*n*=70), *n* (%)	Total (*n*=170), *n* (%)	*P*
Sex				
Male	85 (85)	60 (85.7)	145 (85.3)	0.896 (NS)
Female	15 (85)	10 (14.3)	25 (14.7)	
Side				
Right	30 (30)	44 (62.9)	74 (43.5)	<0.001 (S)
Left	70 (70)	26 (37.1)	96 (56.5)	
Stone location				
Upper ureter	40 (40)	41 (58.6)	81 (47.6)	0.046 (S)
Mid ureter	12 (12)	4 (5.7)	16 (9.4)	
Lower ureter	48 (48)	25 (35.7)	73 (42.9)	
Stone impaction	30 (30)	52 (74.3)	82 (48.2)	<0.001 (S)
Previous stent	20 (20)	30 (42.9		<0.001 (S)
Stent length (cm)				
24	60 (60)	60 (85.7)	120 (70.6)	<0.001 (S)
26	40 (40)	10 (14.3)	50 (29.4)	
Stent diameter (F)				
4.7	15 (15)	70 (100)	85 (50)	<0.001 (S)
6	70 (70)	-	70 (41.2)	
7	15 (15)	-	15 (8.8)	
Site of the upper coil				
Pelvis	60 (70)	50 (71.4)	110 (64.7)	0.124 (NS)
Calyx	40 (40)	20 (28.6)	60 (35.3)	
Site of the lower coil				
Same side	74 (74)	60 (85.7)	134 (78.8)	0.065 (NS)
Crossing midline	26 (26)	10 (14.3)	36 (21.2)	
Stent duration (days)				
14 days	60 (60)	50 (71.4)	110 (64.7)	0.308 (NS)
4-6 weeks	30 (30)	15 (21.4)	45 (26.5)	
6-12 weeks	10 (10)	5 (7.2)	15 (8.8)	

S: Significant, NS: Not significant

patients and 4.7 Fr and 7 Fr are used in 15% of patients. In Group B, stents of 4.7 Fr and length 24–26 cm were used in all patients. The technique was successfully used to deliver the upper DJ coil in the kidney in 91 patients (91%) for Group A versus 57 (84.4%) of Group B patients. Stone-free rate was reported in 96% of Group A versus 94.3% of Group B [Table 3 and Figure 2]. The failure in Group B was due to complications of stenting under ureteroscopic vision without fluoroscopic guidance. In these 13 cases, fluoroscope was used to confirm the insertion of the stent and not added to Group A. The causes of failure to pass the ureteroscope up to the renal pelvis were identified as: small caliber ureter in 7 patients through which the 8.5 Fr ureteroscope failed to pass, the presence of ureteric stricture in 4 patients, and the presence of stone in two anuria patients with a single kidney. In addition, postoperative gross hematuria was reported in 27 patients (15.9%) and was treated with hemostatic drugs. None of the patients required admission to hospital. Postoperatively, we were not able to determine the cause of hematuria as complications of ureteroscopic procedures or due to DJ insertions. The most common complications reported in these patients were lower urinary tract irritative symptoms in the form of frequency and urgency in 108 patients (63.5%). Alpha-blockers and anticholinergic drugs were used to improve these symptoms. Five patients of this group did not respond to the medications, and hence, their DJ stents were removed immediately. Colic was reported in 23 patients (13.5%), and it was managed by analgesics. Upward migration of the stents was observed in 2 (1.2%) patients [Figure 3] and downward migration was observed in 10 (5.9%) patients this called for immediate removal of the stent to relieve obstruction or severe bladder irritative symptoms caused due to the migration of stent to the urinary bladder. Encrustations were seen in 20 (11.8%) patients [Figure 4], but it did not cause any problem during the removal of the stent [Table 4]. When compared with conventional ureteroscopy with image guidance, there was no statistical difference. Group A are exposed to radiation for URSL Mean (26.6 s) and for DJ stenting 4.8 s.

Table 2: Indications of double-J insertion

Indications for DJ stenting	Group A	Group B	Total	*P*
Post URS	96 (96%)	70 (100%)	166 (96%)	0.254
Obstructive anuria	4 (4%)	-	4 (4%)	(NS)
Total	100	70	170	

NS: Not significant, URS: Ureteroscopy

Table 3: Intraoperative parameters among studied groups

Intraoperative parameters	Group A control (*n*=100), *n* (%)	Group B (*n*=70), *n* (%)	*P*
DJ insertion fluoroscopy time (s)			
Mean	4.8	0	NA
Range	2.8-22.3	0	
URS fluoroscopy time (s)			
Mean	26.6	0	NA
Range	16-58	0	
Stone-free rate	96 (96)	66 (94.3)	0.60 (NS)
Repeat procedure	4 (4)	4 (5.7)	

NS: Not significant, URS: Ureteroscopy, NA: Not available, DJ: Double-J

DISCUSSION

Long-term X-ray exposure may pose a serious threat not only to patients but also to urologists.[3] Therefore, efforts should be made to limit such radiation exposure. According to Söylemez *et al*., while 96% of urologists in Turkey use fluoroscopy guidance as the initial choice for percutaneous nephrolithotomy (PCNL), only 2.8% and 1% use US guidance and computed tomography-guided access, respectively. Despite the common use of lead aprons, most urologists do not use dosimeters, eyeglasses, or gloves. Only 46% of

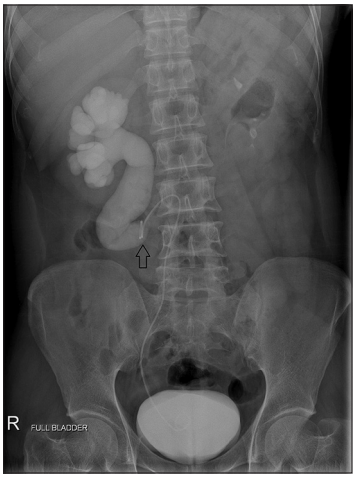

Figure 2: IVP shows coiled doubleJ stent in the proximal ureter and failure to pass it to the renal pelvis due to ureteric kinks and obstruction using the ureteroscope alone. The hook fish sign for a retrocaval ureter is seen clearly in the proximal ureter (see the arrow)

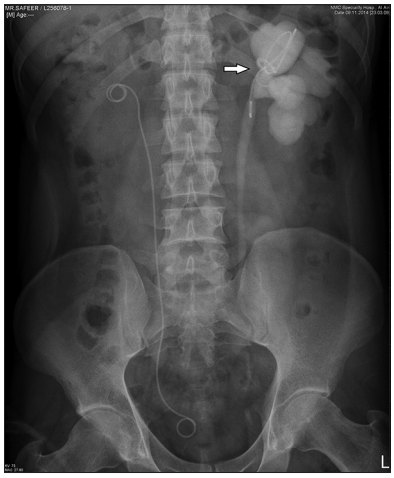

Figure 3: IVP shows migrated double-J stent to the left kidney with hydronephrosis and delayed excretory function of the left kidney due to ureteric obstruction

Table 4: Complications of double-J insertion

Complication	Group A control (*n*=100), *n* (%)	Group B (*n*=70), *n* (%)	Total (*n*=170), *n* (%)	*P*
Failure to insert the stent	9 (9)	13 (18.6)	21 (12.4)	0.186 (NS)
Migration upward	1 (1)	1 (1.4)	2 (1.2)	0.798 (NS)
Migration downward	6 (6)	4 (5.7)	10 (5.9)	0.938 (NS)
Encrustation	14 (14)	6 (8.6)	20 (11.8)	0.279 (NS)
Stone formation	2 (2)	-	2 (1.2)	0.233 (NS)
Colic	13 (13)	10 (14.3)	23 (13.5)	0.809 (NS)
Storage symptoms	60 (60)	48 (68.6)	108 (63.5)	0.253 (NS)
Gross hematuria	15 (15)	12 (17.1)	27 (15.9)	0.706 (NS)

NS: Not significant

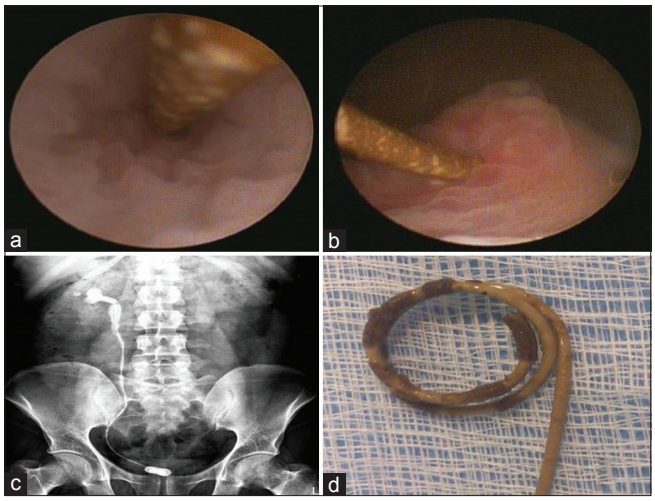

Figure 4: (a) Intraureteric stent shows encrustation around the shaft of the double-J stent, (b) intravesical double-J stent with encrustation around the stent and edema around the ureteric orifice, (c) kidneys, ureter, and bladder X-ray with a neglected right double-J stent and stones are formed around the upper coil and lower coil of the stent, (d) a coil of a double-J stent with encrustation after removal

the urologists always use thyroid shields during fluoroscopy. Urologists consider the usage of flexible protective clothes as impractical because they are heavy and rigid.[4]

The impetus to perform fluoroscopy-free procedures is not unique to urology. Many centers have replaced fluoroscopy by US-guided PCNL technique.[5] Mandhani *et al*.[6] in 2007 showed that complete clearance of distal ureteral stones, below the sacroiliac joint, could be achieved without the use of fluoroscopy in 99 out of 110 patients. Their study also showed that fluoroscopy-free balloon dilatation of the distal ureter can also be achieved under direct vision.

However, our study is not the first to describe and quantify the results of a technique for URSL and ureteral DJ placement without any form of image guidance. Akif and Bayrak[7] also described a similar technique, but they used forceps. The technique was safe and effective and avoided the use of fluoroscopy. However, the problem in this technique was the usage of the forceps after removal of the guidewire and the pusher and the insertion of the forceps to touch the end of the DJ stent inside the ureteroscope to complete the insertion process. In our technique, we avoided this step by using a long pusher from the beginning, which completed the insertion up to the delivery of the lower coil of the stent in the urinary bladder.

Although we wear protective aprons and all cautions are taken during fluoroscopy-guided URSL and DJ stenting, our team exposed to mean 26.6 s for URSL and mean 4.8 s for DJ stenting.

This fluoroscopy-free ureteroscopic technique was undertaken cautiously in the early cases. The technique was used after extensive experience with reduced fluoroscopy protocols. Greene *et al*. 2011,[8] Brisbane *et al*. 2012,[9] Blair *et al*. 2013.[10] We have previously reported a reduced fluoroscopy protocol that allowed us to reduce the fluoroscopy use during flexible URSL.[11] As we became comfortable with these reduced fluoroscopy techniques, we realized that ureteroscopy could be performed entirely without fluoroscopy in carefully selected patients.

In our institution, fluoroscopy-free DJ stent placement has evolved as we used progressively less fluoroscopy during endoscopic cases. We believe that this technique could be easily incorporated into any urologic practice, which will reduce the use of fluoroscopy in all patients undergoing URSL.

Ureteral stent insertion is traditionally performed using a cystoscope guided by a fluoroscope. However, the fluoroscope is not always available[12] and so the procedure is often performed blindly. Due to the extensive use of DJ stents in urology, many complications have been reported.[1,13]

The present new technique described here may be beneficial for URSL and retrograde DJ ureteric stenting by ureteroscope 8.5–11 Fr. Our technique is useful for insertion of DJ stents to the ureteral lumen after passing the area of obstruction by ureteroscope. Moreover, the technique appears to be safer, even though the ureteroscope cannot reach the renal pelvis because the DJ stent is placed under endoscopic vision. In addition, this method can be safely used without fluoroscopy guidance.

Sometimes, the insertion of a ureteric stent is difficult due to severe ureteric stenosis; multiple kinks in the ureter may need confirmation by fluoroscopic imaging.[14,15]

The DJ stent can also be placed with a pusher through the ureteroscope working channel. However, this method requires a second pusher as one pusher is not long enough to place the stent. Occasionally, another DJ stent set is needed for the second pusher, or if available, a separate pusher is used, thereby increasing the cost of the procedure.

Kose *et al*.[16] prescribed manual replacement of DJ stent as a new technique to avoid the use of fluoroscopy. They practiced their new found technique on 23 female patients. In this technique, the distal end of the DJ stent is taken out through the urethra. They inserted a 0.035-inch guidewire through DJ stent to the pelvicalyceal system. The old stent is pulled out over the guidewire and a new stent is inserted over the guidewire. We found this technique was easy and simple for women, but for men, it was difficult due to the long urethra. This technique is considered to be a blind technique. Contrary to this technique, our one-step technique is suitable for men and women, and it is also under vision without the use of fluoroscopy.

With our technique, the operation time can be reduced due to the free movement of the team, the lack of use of aprons, protective shields, and the avoidance of moving the fluoroscope in and out of the operating table. In the future, we plan for a prospective study to compare the operative time, radiation exposure, and complication rate between the fluoroscopic and fluoroscopy-free techniques.[11,17] We claim that it reduces the operative time and gives free movement of the operative team without the presence of the fluoroscope. On the other hand, this technique has a few drawbacks. The insertion of the DJ is considered a blind procedure in therapeutic cases when the ureteroscope 8.5–11 Fr is not able to reach the renal pelvis due to the presence of stone or ureteric stricture that may cause renal and ureteric injuries. Fluoroscope could be used briefly in these situations to confirm the presence of upper coil in the renal pelvis. There is also the need of two semi-rigid ureteroscopes for ureteric dilation under vision, which is not affordable to many centers and probably increases the cost of the procedure. However, it is considered to be simple and feasible post-URSL and flexible URSL.

Complications

Our technique failed to insert the ureteric stents without the use of fluoroscopic guidance in 13 patients (7.6%) due to ureteric kinks or strictures, and our 8.5 Fr ureteroscope was not able to pass the area of stricture, impacted by stone. Other complications reported are similar to previous studies and due to the stent itself and not due to the technique of insertion.[11,17]

Al-Marhoon *et al*.[18] reported minor complications such as dysuria, frequency, hematuria, flank, and suprapubic pain. They reported vesicoureteral reflux, migration, encrustation, urinary infection, stent fracture, necrosis, and ureteroarterial fistulas as major complications.[19-22]

One limitation of this article is that it is retrospective, and therefore unable to describe the patients in whom the fluoroscopy-free technique was converted to image guidance. The time of radiation is reported but the dose is not calculated. Ureteric stones should be studied separately proximal, middle, and lower groups. There were no renal stones after flexible ureteroscopy and laser lithotripsy included in this study. Although these differences do exist, both differences make the fluoroscopy free group a clinically more challenging.

We continue to revise and adjust our indications for a fluoroscopy-free approach as our experience increases. This technique is not appropriate for all patients. Patients who currently would not meet fluoroscopy free criteria in our institution include those with ureteral strictures, entombed stents, significant anatomic abnormalities, and tightly impacted stones. In our center, we do not routinely employ ureteral access sheaths and subsequently this study does not determine the safety of the fluoroscopy-free technique when using a ureteral access sheath. If the surgeons do not feel that they can adequately endoscopically map the entire collecting system to ensure complete fragmentation of all stones, they should not hesitate to employ fluoroscopy.

While this study shows favorable patient outcomes in fluoroscopy-free ureteroscopy, it does not address the additional stresses that may be placed on physicians performing these procedures. Certainly, the fluoroscopy-free technique is a significant departure from the conventional technique and it should not be attempted until the surgeon has extensive experience with low radiation protocols for ureteroscopy. The intent of this study is not to suggest that fluoroscopy free URSL should be routinely performed in all patients. Rather, the intent of this study was to determine whether ureteroscopy without fluoroscopy or other image guidance was feasible and whether it could be safely performed in carefully selected patients. Rigid application of this technique to all patients by surgeons unfamiliar with the technique could result in patient harm. In addition, even experienced surgeons should have a low threshold for employing fluoroscopy if any ambiguity is encountered.

We strongly recommend that if there is any ambiguity in the case or uncertainty, the surgeon should not hesitate to employ fluoroscopy using a low-dose protocol. Future prospective randomized trials will be needed to delineate optimal patient candidates and to assess the risk–benefit ratio associated with specific patient profiles and surgeon experience levels. In addition, we will continue to maintain a low threshold for converting to a fluoroscopy-guided technique in the event of any uncertainties or intraoperative concerns.

Our goal was to reduce the amount of fluoroscopy required during urologic procedures.

The present study, despite a small number of cases, provides valuable evidence of DJ stenting without fluoroscopic guidance. Nonetheless, further randomized controlled studies are needed to draw firm conclusions.

CONCLUSIONS

Our technique is simple and was safely used to place DJ stent postureteroscopic procedures. It may reduce procedure time and radiation exposure, and it avoids the potential complications of blind catheter placement without the use of a fluoroscope.

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Conflicts of interest
There are no conflicts of interest.

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